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## Industrial Progress.

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## ANNOUNCEMENTS.

FEILDEN'S MAGAZINE is published at the *beginning* of every month.

In consequence of the large number of pages to be prepared and passed for press, the careful nature of the printing required for high-class production, the advance arrangements made for extensive circulation, and in order to facilitate departmental business, observance of the following rules is necessary:—

**Literary Matter** to reach the offices not later than the 1st of the month (as much earlier as possible) previous to date of publication. Communications to be addressed "Editorial Department."

**Advertisements** intended for insertion in next issue must be received not later than the 15th of the month (as much earlier as possible), to insure correct classification. All communications respecting same to be marked "Business Department." Advertising Rates, on application, regulated according to positions available.

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For Buyers' Guide, Index to Advertisers, and Directory of leading British Manufacturers, see pages ii. and iv. of second cover, and pages iii. to xiv. (in first part of Magazine).

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## IMPORTANT.

The high standard attained in the production of FEILDEN'S MAGAZINE has elicited a eulogy from all parts of the world unexampled in the history of technical journalism. Satisfied as the Proprietors might well be with the result achieved, arrangements of an important and far-reaching character have been concluded at great expense whereby the attractiveness, value and prestige of the Magazine will be still further enhanced. Special features, together with particulars of forthcoming events, will be published next month.

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**THE EDITOR will be pleased to consider Literary Contributions dealing with subjects within the purview of this Magazine, and to make satisfactory arrangements with Contributors if MSS. be accepted for publication. High-class engravings from photos and drawings will be prepared free of cost to the writer.**


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# Some British Commercial Characteristics.

In a general sense, the gentleman of the "old school" is growing extinct. It is true he may still be seen occasionally, clad in the garb of his forefathers, traversing, with a curious mingling of stateliness and timidity, some off-shoot of a main thoroughfare. But he will not long remain with us. He shrinks instinctively from the turmoil of modern life; and, in fact, retains little of the characteristics of those his memory clings to so fondly except their clothes. These he treasures with reverential affection; and he takes a pride in exhibiting them to the world. They may be out-of-date, cumbrous, and, to the current idea, even preposterous. But their wearer knows that the same clothes were worn by those whose deeds were glorious—"The men, sir, who made the country. What was good enough for them is good enough for me. You, sir, do as you please. You may be right, or you may be wrong; but your ways do not suit me. I believe in the 'good old English.'"

This quaint habit of mind, thus confounding the shadow with the substance, is not one that would be expected to prevail among a people so practical and hard-headed as the English are supposed to be. Nevertheless, it finds many a true analogue in England's trade and industry, and has wrought a great though unsuspected influence on the commercial position of the country at large.

It is an unquestionable fact that there is a kind of trade aristocracy among us, based on much the same principle, and guided by many of the influences associated with family aristocracy itself. And if we are to assume that aristocracy so-called is based chiefly on position and heredity, there can be no difficulty in according a qualified form of this distinction to notable and other mercantile houses which look back for the period of their establishment to the time of bye-gone generations.

With many of the old-established houses it is a point of honour to maintain in their integrity all the ancient traditions of the establishment. The old customs, the old methods of business are slavishly adhered to, however discordant with economical conditions that have so entirely changed since they were introduced. They do not appear to appreciate the truth, that business methods which might be entirely appropriate fifty years ago are now utterly at variance with the spirit of modern days. Fifty ago, indeed, the large manufacturer and merchant was on a very different footing. He was, generally speaking, the superior of his customers; at all events, he considered himself so. He sold them his goods or his manufactures with a lordly condescension; and if any favour entered into the transaction at all, he claimed it. He never dreamed of "running after" a customer; his customers came to him. He carried his affairs with a high hand, and—competition being not as we understand it—fixed his own prices. Notwithstanding, he was on the representation an epitome of probity, generous and straightforward. He was, too, full of enterprise, and in his speculations daring even to excess. No new market was too remote, too difficult, or too dangerous for his undertakings. His products were scattered over the whole world, at a period when the difficulties of distribution were beyond our powers to adequately realise. Only, he carried on his trade on principles which to-day are impossible. He took his customers in the bulk. He supplied countries, districts, towns, but not individuals. He was "wholesale" in the widest sense of the term. Hence his princely position, his autocratic, though just, business policy, his ingrained disposition to undertake things on the great scale, to leave the droppings of his enterprise to humbler practitioners.

The typical British merchant has gone. He has gradually disappeared with the conditions that alone permitted his existence. Now there are no new markets, and in those that are open we are jostled on every side by a multitude of eager, able competitors. The world's trade is no longer our natural monopoly—it has long ceased to be that—and we are being

driven even from the share we still possess, slowly, but steadily and surely.

We have referred to the fact of British merchant houses clinging to the worn-out methods of their predecessors. Precedent, in many, was never more rigidly followed in the Courts of Justice. "We do not employ travellers: we have never done so." "Advertise? Certainly not; we consider it beneath the dignity of this firm to have recourse to such a means of obtaining business." An obstinate self-sufficiency that disdains, or even resents, any suggestion at improvement, and a blind reliance on out-of-date methods which they continue for no reason excepting that of their being handed down to them, are unfortunately too often the characteristics associated with the title "old-fashioned," which so many business houses in this country pride themselves on possessing.

It is natural, however deplorable, that the haughty spirit—at some times approaching arrogance—that distinguished the British merchant of the past age should have been handed down to and been preserved, in a measure, by his successors. Year after year, and from all quarters of the world, British consuls voice the universal complaint. He will not deign to consult the consumer. "There," he says in effect, "are my goods, with the accumulated prestige of seventy years behind them. You are the first person who has dared to criticise them. Either take them, or go elsewhere." The consumer, as a matter of fact, goes elsewhere; and it is a circumstance which many of our firms, somewhat to their dismay, are beginning to find out. They are also becoming aware that trade is much easier to lose than to recover—that even to recover a lost market the most desperate exertions may be made in vain.

We do not put it forward as more than a purely ethical principle, but as that the proposition is maintainable, that the manufacturer and exporter who enjoys the protection and resources of this country has a duty towards it in the prosecution of his business as well as the consultation of his private interests. Loss of trade to the individual means a loss to the nation at large, and on a large scale it is felt by every class of the community. A lassitude and neglect, therefore, in the carrying on of foreign trade is not merely a personal matter but one in which the public, who pay for an immense floating armament to protect our oversea commerce, have a direct concern. We have to recognise that the methods of past years must be abandoned for ever. We shall have to step down from the lofty seat we have been reclining in for so long, and meet our competitors and fight them with their own weapons on their own ground. We must pursue the customer, instead of his pursuing us. In our dealings with him we must endeavour to ascertain his idiosyncrasy and meet his wishes. In a word, we must give him what he wants instead of what he can be induced to take. If our manufacturers and exporters, then, can be prevailed on to part with some of their superciliousness, to adopt the aggressive, and to make a determined effort to beat the foreigner at his own game, neither we nor anyone else is entitled to fear the result.

## Liquid Fuel.

Of late there has been a scare as to exportation of Welsh coal to the Continent which is intended to be used by the Continental Governments as a smokeless fuel in the ships of their fleets. Questions have been put in Parliament to the First Lord of the Admiralty whether or not he can do anything to prevent this valuable national asset from leaving these shores. It has also been proposed to place a tax on all exported Welsh coal which is to be used by foreign countries; and the Navy League, a fairly powerful body, has promised to make things very lively should Welsh coal be used for any other purposes than those of the British Navy. Whatever may be ultimately done to keep and preserve the smokeless Welsh coal for the British Navy, the question of the provision of a smokeless fuel for the navy is one of paramount importance, and one is led to consider the fitness of liquid fuel for this purpose because of

its demonstrated success as a fuel in ships trading in eastern seas which are distant from the Welsh coal fields. Welsh coal at Singapore is a very different thing in price to what it is at Cardiff and at British ports. Roughly speaking the price of Welsh coal at Singapore or at Hong Kong is not very much under, if it is not over, 30*s.* per ton; and liquid fuel, like Borneo oil, might be expected to compete with coal in Eastern seas where it must be bought at so high a figure. The feasibility of its competing with coal as a steam raiser has anyway demonstrated itself to the Hamburg-American Company, who are fitting their steamer *Saxonia* with the necessary apparatus for burning liquid fuel, and contracts have been arranged for the fitting of six other steamers; the China Mutual Company have stated through their chairman that provision will have to be made for its use in all future steamers built to their order. But setting aside for the moment a consideration of the vessels projected and intended to use oil as fuel, it may be pointed out that at present there are quite a respectable number of vessels using oil as fuel, and using nothing else in Eastern seas. All the later vessels built by Messrs. Armstrong, Whitworth and Co. for the Shell line are using regularly liquid fuel, and many of the vessels trading and carrying passengers on the great lakes of America use it with great success. Up to the present, however, ships which are regularly using oil in Eastern seas are fitted so that coal may be used as fuel in Western seas. There is one advantage of this arrangement. That advantage is, that a comparison can be made between the two systems of steam raising. One steamer, the ss. *Clam*, was fitted so that it could use either coal or liquid fuel. She had three single-ended cylindrical boilers, and when coal was the fuel the three boilers had to be in use so as to maintain steam. Now, when using liquid fuel two boilers are sufficient to maintain steam, and make the same speed as before. With liquid fuel excellent combustion is obtained with a very high temperature, with the result that with the same furnace space and same heating surface the evaporation is greater. Under such conditions there is less boiler space required per i.h.p., and the same advantage in this respect is brought about as is claimed for the water-tube boiler.

At the recent meeting of shareholders of the P. and O. Company, Sir Thomas Sutherland said the item of coal alone had raised the expenses of working by £200,000 per annum. If this be so, and other companies are suffering in the same direction, then it is possible that they may be forced into using liquid fuel.

The difficulty of its distribution and the provision of oil-supply stations, is about got over. At all the important ports of call along the South and Eastern Asiatic coasts there have been established by Messrs. Sir M. Samuel and Co. large oil depôts. Large oil reservoir tanks have have been fitted at Bombay, Colombo, Penang, Singapore, Bangkok, Hong Kong, Shanghai, Kobe, and Yokohama.

One of the difficulties of working with oil has been the necessity of using steam to blow in the oil feeding apparatus to pulverise it before it will burn properly. It is the same difficulty as that which crops up in Meldrum's and Gosling's system of forced draught, and prevents their use at sea. It is said that some two per cent. of the steam formed requires to be blown through the nozzle of the liquid fuel apparatus in order that it may be pulverised and suited for proper combustion. This is a great waste, especially as one wishes to make up for as little waste feed-water as possible. However, this is again a question of cost, and it may pay to increase the capacity of the evaporator by two per cent. to make up the extra loss in pulverising the oil. There is another difficulty, and that is the hissing sound caused by the steam blowing the oil and pulverising it in the furnace. But it would not annoy a stokehold full of stokers, for only one man is really required to be on watch and see that all is going right. But even this difficulty is being overcome. We believe when hot air is used to pulverise the oil there is an absence of the annoying noise and a complete saving of the steam. The last ship launched for the Company has

been fitted with a blowing apparatus which uses hot air instead of steam for pulverising the oil. The *Cardium*, launched in March, has three boilers and steams under oil with two. It is the intention of the owners to work the two boilers one with hot air blowing apparatus, and the other with steam, and carefully record the results so as to determine which is the more economical system. In a way this heating of the air before it mixes with the fuel is not unlike some of the systems of forced draught, notably those of Howden and Ellis and Eaves. It is claimed for these systems that they are followed by a more perfect combustion of the coal, and the results of working seem to favour this view. In the same way it is claimed that hot air as a pulveriser has other advantages than simply saving steam and preventing noise. There is better combustion. Both the air and the liquid fuel are better prepared to begin to combine, and when they do so better results follow. The experiments to be made on the *Cardium* will be looked forward to with considerable interest in engineering circles, especially as those made on H.M.S. *Curly* did not determine anything.

## Metropolitan Street Traffic.

No one is likely to deny the urgency of remedial measures in connection with street traffic. The question has already occupied the attention of several well-known engineers; only quite recently it was mentioned by Sir Douglas Fox in the course of his presidential address to members of the Institution of Civil Engineers, and since then it has formed the subject of a paper read before the Society of Arts by Sir John Wolfe Barry.

Something has already been done by the opening up of new main thoroughfares, and no doubt work in this direction will be continued with due deliberateness. Unfortunately the race of unwieldy monsters, which we call omnibuses, seems to possess such amazing power of proliferation, that every fresh avenue intended for the general convenience is promptly overrun. There appear to be only two practicable remedies at present available; the establishment of rapidly moving tramway vehicles, and the extension of underground electric railways. Many theories have been advanced to account for the habitual backwardness of London in all matters of municipal improvement, but the true reason appears to be a deep-seated mystery. So far from adopting methods of traction common in every large provincial town, our tramway cars are still laboriously dragged, at the average speed of about five miles an hour, by weary horses whose duty is considerably increased by frequent stoppages at apparently unnecessary places.

Electric traction and the inauguration of a scheme providing for recognised stations where non-athletic passengers might not only enter or leave the cars, but might also secure seats without the exercise of more than ordinary muscular strength, would do much to alleviate the sufferings of the average London citizen. In this connection it may be interesting to notice the comparative results afforded by three systems of traction in use by the Metropolitan Street Railway Company of New York. One admirable feature exhibited by this corporation, is the publication of annual statistics of the cost of operation on its system. Thus the public are put in possession of data which cannot fail to be of great advantage when problems relative to traction are under consideration.

At the present time the company has in operation over 113 miles of horse railway track, about 25 miles on the cable system, and 82 miles worked on the conduit electric system. From the last published figures we have compiled the table given below, and it should be remarked that the results obtained possess especial value from the fact that all the systems are under one board of management and are worked in one city. Therefore, comparisons drawn are in no way deprived of significance as frequently happens by reason of dissimilar conditions existing in the examples selected.

Results contained in the table are stated in cents per car mile.

| | Electric Traction. | Horse Traction. | Cable Traction. |
|---|---|---|---|
| Maintenance— | | | |
| Permanent Way ... | 0·68 | 0·99 | 4·69 |
| Equipment ..... | 1·17 | 0·42 | 1·13 |
| Power ..... | 1·77 | 6·69 | 2·39 |
| Transportation ..... | 7·06 | 8·24 | 8·43 |
| General Expenses ... | 1·27 | 1·62 | 1·35 |
| Total per car mile.. | 11·95 | 17·96 | 17·99 |

It is somewhat surprising to find the cost of cable traction so heavy, but there are special reasons for this in New York. The traffic in the ordinary way is very heavy, as cars are frequently run at intervals of ten seconds, and last winter, owing to snowstorms, serious blocking of the electric roads occurred. During this period, when double duty was required from the cables, a new rope would last for little longer than a week, and as a matter of fact fully 2·30 cents out of the total of 4·69 per car mile was expended on cable maintenance alone. Horse traction, on the other hand, shows in an exceptionally favourable light, because of various economies in management and in consequence of reductions in the cost of fodder and general supplies.

Comparing electric traction with horse traction we find the statistics furnished represent a saving of fully 33 per cent. The low expenditure in respect of maintenance is said to be due to the fact that some of the plant is new, and consequently has not had time to show signs of wear, but against this, the amount set down for power is inclusive of payments in respect of a cross-town horse line, which, as it joins several electric routes, is considered to form part of the general electric system. Excluding such items, the cost of electric power in 1899 was 1·57 cents. per car mile, and the completion of a new power station of 70,000 horse-power is expected to be productive of further saving.

Looking now at the proportions existing between working expenses and traffic receipts, we find them to be as follows :—

| System of Traction. | Working Expenses. | Traffic Receipts. |
|---|---|---|
| Electric ..... | 38·3 | 100·0 |
| Cable ..... | 50·8 | 100·0 |
| Horse ..... | 69·8 | 100·0 |

Here again a very great advantage is shewn to be derived from the employment of electricity, and there are other points in its favour, namely, the smoother running and more commodious cars, and the higher speed attained. One drawback has certainly been found, for which the company cannot be blamed, inasmuch as it was caused by public competition for seats in these superior electrically drawn cars. In this connection it is interesting to find that proposals are made for relieving congestion of traffic by the construction of underground electric railways, so that long distance passengers may be rapidly taken to their destinations, leaving surface lines comparatively free for short distance fares. Thus we see the problems of street traffic in New York are growing more and more like those of our own metropolis. It is for us to profit by the accessible results of experience, and to abolish antiquated methods with the least possible delay.

## London Water Supply.

NOTHING gives rise to so much discussion, or causes the ebullition of so much perfervid feeling, as cold water. Total abstainers are justly celebrated for the height to which their oratory ordinarily attains, and for the amiable manner in which they would regulate the customs and habits of less virtuous people; and Radical members of the London County Council, although not quite so eloquent, have an equally strong desire to control the drinking supplies of their fellow creatures. It matters very little to these enterprising councillors how their purpose is to be carried into effect. They are ready either to buy out the existing water companies, or to start an opposition undertaking of their own; in fact, they are willing to do anything—of course, at the cost of the ratepayers—so long as

the public water supply can be brought within their own jurisdiction. Fortunately for the pockets of the inhabitants at large, the consent of Parliament is necessary before any drastic step of this nature can be taken, and there are satisfactory reasons for believing that Parliament will not prove susceptible to the blandishments of the County Council and its persevering supporters. Connected with the water supply of the Metropolis there are three burning questions:—(*a*) Whether control should remain in the hands of the companies as heretofore; (*b*) whether it should be vested in the London County Council; and (*c*) whether it should devolve upon a central board acting in the interests of the community. There is also the consideration, affecting all these alternatives, whether the Thames Valley or Wales should constitute the future source of supply. All these matters have formed the subject of careful enquiry by two Royal Commissions, one under the presidency of Lord Balfour, and the other of Lord Llandaff, and in each case, scientific evidence has received every consideration. Generally, and looking ahead for the next forty years, the Commissions have come to the conclusion that the Thames Valley is fully capable of furnishing water in sufficient volume, providing facilities for storage are given, so that the superfluity existing in times of flood may be put aside to augment supplies in seasons of drought. The Llandaff Commission has further arrived at the conclusion that the control of the metropolitan water supply should be in the hands of a central authority, but that this authority should not be the London County Council. These authoritative pronouncements are so directly opposed to the policy of the Council that it is difficult to see how that body can justify the continued expenditure of public money in the promotion of Bills, which must inevitably be, and now have been, rejected by Parliament. Shortly before the second reading of these ill-fated measures was moved in the House, Mr. Shaw Lefevre made an effort to enlist sympathy on behalf of the views held by himself and his friends by writing a series of letters to *The Times*. Whether Mr. Shaw Lefevre embarked on this hazardous enterprise on his own initiative, and was impelled to speak out of the fulness of his own heart, or whether he was, so to speak, pushed into the gap and told what to say by more prudent friends and advisers, we do not know. The fact remains, that he has been very badly worsted Taking his first letter, we find that he endeavoured to alarm the public by suggesting danger from the storage reservoirs which it is proposed shall be constructed in the Thames Valley. One of these reservoirs, at Staines, is already partly made, and it has been visited by Mr. Shaw Lefevre, who, apparently, considers that the engineers responsible for its design are totally imcompetent to build such a reservoir so that it shall be safe. We need not mention in detail the erroneous theories, nor the inaccurate statements, made in his letter with regard to engineering matters, because no one will be likely to take them seriously. They were obviously nothing more than a feeble attempt to show the wickedness of the Thames Valley scheme in contrast to the inherent virtue of the alternative Welsh scheme. It is somewhat amusing to notice the singular demonstration of logical reasoning contained in the letter in question. Mr. Shaw Lefevre doubted the "sanity and intelligence" of any one who could recommend so enormous a reservoir as that at Staines, but he extolled in glowing language the desirability of the still larger reservoir forming part of the proposed Welsh scheme. As the capacity of the former will be 3,300,000,000 gallons, and as that of the latter was to have been 39,000,000,000 gallons, one would rather be inclined to say that "sanity and intelligence," if involved at all, should be in an inverse proportion to the number of gallons contained in the respective reservoirs. Passing on, we observe that the letter proceeded to condemn storage works in the Thames Valley on the score of ugliness. There is more reason in this contention, but we are not sure that reservoirs are necessarily uglier than rows of suburban villas, gas-works, linoleum factories, railways, sewage farms, and

other inevitable adjuncts of civilisation. If London is to be supplied with water, reservoirs must be provided, whatever be the source of supply, and the condition applies equally to the Welsh scheme. After experiencing a crushing reply from Sir Frederick Bramwell on engineering matters, Mr. Shaw Lefevre wrote a second letter to *The Times*, in which he devoted himself to prove that the Llandaff Commission had made a trifling error of some £6,000,000 in their estimates as to the cost of the two rival schemes, and by substituting for the correct figures some calculations of his own, he succeeded most admirably in his demonstration. His belief seems to be that whilst estimates prepared by other people are likely to be vastly exceeded, those made by the County Council are sure to be above the actual cost. This simple faith is really very touching, and there are many ratepayers who would welcome the smallest sign by which it might be justified. Mr. Shaw Lefevre's second letter is a valiant attempt to prove that the larger scheme should cost less than the smaller one, which is somewhat like the proposition that the whole is smaller than its part. Even his able advocacy did not save the County Council Bills, and Londoners may rejoice that for some time to come they will not be called upon to bear the heavy expenditure which would inevitably accompany the realisation of the Welsh water scheme.

## The Paris Exhibition.

THE Paris Exhibition, concerning which so much has been written and expected for months past, was formally opened on the Saturday preceding Easter Monday by the President of the French Republic amidst a scene of almost unexampled enthusiasm and splendour.

Never before, perhaps, have so many vicissitudes attended the initial stages of an undertaking the fundamental principle of which involves international unity and concord.

The odium into which France was plunged through the Dreyfus case seriously menaced the chances of the exhibition of 1900 ever becoming a *fait accompli*, as, at one time and in more than one country, the chances of a number of exhibitors withdrawing from their engagements was more than problematical, to say nothing of that feeling akin to disgust which, but for the satisfactory compromise arrived at, would have diverted from Paris thousands of visitors. As far as Great Britain is concerned this feeling had scarcely died when it was resuscitated in an aggravated form by the unwarrantable vituperation cast by the less respectable members of the French press upon the English Royal Family and the Army in South Africa.

It may, however, be assumed that for the next six months, at any rate, the inclinations of that portion of the French community who have been applying their energies to foment Anglo-French discord will be towards maintaining a feeling of goodwill—simulated or genuine—without which the complete success of the exhibition might stand in some jeopardy.

The uncertainty of French affairs generally has not been without its effect upon FEILDEN'S MAGAZINE, as owing to this cause the proprietors deemed it advisible to delay the preparations of the special Paris Exhibition number announced as far back as November last until the good sense of the French had finally asserted itself. Time requirements, however, have now rendered it necessary to abandon the original project. At the same time steps have been taken to secure an adequate representation at the Exhibition, and more than one special commissioner will be despatched to report upon the British Exhibits and the more meritorious or interesting of those shown in the foreign sections.

Appealing as it does to the curiosity of all, and now that the disturbing elements are eliminated or allayed, the Exhibition bids fair to be a huge success, and it will be a mistake to allow any prejudice, however well-founded, to cause us to under-estimate its importance to the manufacturer in the stimulus it will undoubtedly give to trade and to international rivalry.

**"We are, in the vastness of our possessions, losing our grip on national sentiment. It is our duty to maintain intact, and to defend by sea and land, all that our empire builders have left us. The day that sees the defence of the British Empire sapped, sees the disintegration of the Nation's trade and the hands of civilization's timepiece put back 200 years."**—RT. HON. LORD CHARLES BERESFORD, C.B.

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## The Spring Meeting of the Institution of Naval Architects . . .

THERE was a good selection of papers read before the Institution of Naval Architects at its spring meeting, held in the hall of the Society of Arts on the 4th, 5th, and 6th of April. These papers extended to fifteen in number, and they ranged very nearly over the whole ground of naval architecture. Although the excitement of previous meetings was perhaps not reached, interesting discussions took place on nearly all of the papers. Only one or two of the papers were confined to a mathematical treatment of the subject of which they dealt, and the interest in most of them was distributed over the whole of the members. The secretary had a very favourable report to read.

The reference by the chairman in his address to the magnificent work performed by the mercantile marine by its transport up to February 17 of 132,000 officers and men, together with 50,000 horses and mules, and the stores and materials for this large force, was received by the members with some pride, since it showed what the country could do when suddenly called upon. On the other hand, the chairman was able to show that the building of mercantile ships had also broken all records during the year, for no less than 1,416,791 tons had been the output for 1899, a figure which beat the previous year by 49,000 tons. The records also show that there is a preference by the great shipping lines for large vessels. No less than sixteen vessels of 10,000 tons and upwards were being built, the largest being the *Ivernia* of 13,900 tons.

Large vessels being the desideratum of the ship owner, the paper read and the discussion begun by Professor Biles on "Large Cargo Steamers," was probably the most interesting of the sitting. The question which he raised was the best manner of increasing the carrying capacity of a ship without increasing the cost of carriage per ton per mile, and if possible decreasing the cost. Up to the present the experience had been that increase of size of cargo steamers had been followed by a decrease in the cost of carriage per ton per mile. The question was now whether the further increase of the size of the cargo steamer would be followed by a decrease in the same way? In the paper read by Mr. Hunter, at Newcastle, on a type of Atlantic cargo steamer, the dimensions were 500 ft. in length, 60 ft. breadth, and 36 ft. depth to upper deck and 44 ft. to shelter deck; draught of water loaded 27 ft. 6 in.; deadweight 12,000 tons; capacity 20,000 cubic feet at 40 ft. per ton and 1,000 tons coal space. The speed was assumed to be 12 knots and the consumption of coal 56 tons per day, which would be about 3,500 i.h.p. at 1·5 lbs. of coal per i.h.p. per hour. Using these figures as a basis to estimate corresponding figures for vessels of larger dimensions, the elements which varied with the dimensions were—weight of hull; weight of machinery; weight of coal; capacity; weight of cargo; and the elements assumed to be constant were—general character of form; speed; coal consumption per i.h.p.; dis-

tance cargo had to be carried. He made estimates for ships ranging from 500 ft. to 700 ft., and found that when the draught was kept constant the cost per ton of cargo carried increased with the size; but when draught was increased proportionately the cost of carriage per ton decreased. Putting it broadly, the 700 ft. ship would carry 12 tons 5,000 nautical miles for the same cost as a 500 ft. ship would carry 10 tons when the depth was increased proportionately, and the 700 ft. ship will carry 7·7 tons for the same cost as the 500 ft. ship carries 10 tons when the depth is constant.

Of course there are difficulties in the way of increasing the depth and draught of ships. It is not every harbour which will allow a ship of greater draught than 27 feet 6 in. to enter. At the present time foreign governments, and especially the German government, are agitating for an increased depth being given to the Suez Canal. Battleships have been known to require the guns to be removed in order to lighten them sufficiently to go through the canal. The P. and O. steamers are restricted in draught because of the necessity of going through the canal, so that an increase of draught would entail great expense in the deepening of the canal and the harbours use. But there is another difficulty, which was pointed out by Mr. West. At the present time it is only in the Atlantic trade that there is an outlet for the usefulness of a large cargo ship. There may in the future be so great an increase in the trade between this country and the Continent, with the Cape and Australia, as to justify the use of large cargo steamers; but at present the trade would not warrant the employment of vessels of greater length than 500 ft., and outside of the Atlantic trade they would require to work under the higher rates entailed by the employment of the smaller vessel.

**The Vickers Patent . . .**

IT is satisfactory to learn that our Government have recently completed an arrangement by which they have power to manufacture mechanisms of all calibres under the Vickers Patent up to and above 12 in. This is decidedly in the line of progress, but so many new improvements have been devised by such firms as Schneider & Co. in France, Krupp in Germany, Messrs. Vickers, Son & Maxim in England—especially as regards the adaptation of field artillery to widely varying conditions—that an almost radical change seems to be necessary in our armaments if we desire to be on the same level of excellence with our rivals. Many of the most striking improvements in regard to artillery are due to the energy of private inventors, and Continental Powers are not slow to avail themselves of their services. The inventor in our country meets with but scant courtesy from our War Office, and not only there but even at the Patent Office he is treated more as a ready milk-cow than as a customer who has a right to claim some assistance, considering the revenues which the Patent Office derives from him.

**An Improvement in our Patent Laws . . .**

WAS one of the first measures of progress advocated in FEILDEN'S MAGAZINE, and six weeks later we had the satisfaction to learn that Mr. Ritchie, the President of the Board of Trade, had appointed a Departmental Committee upon the subject of patent facilities. Since then there has been further progress, for on March 14th, at the banquet of the Association of Chambers of Commerce, held at Whitehall Rooms, London, Mr. Ritchie stated that he

> "admitted the Government did not do what it might. It had appointed a committee to inquire into one branch of the subject. That, however, was only a stepping-stone, and Sir E. Fry had consented to be a chairman of another committee, which should effect means by which searches should be made easy, to enable patentees to ascertain whether or not their inventions had been anticipated. It was alleged by Manchester that foreign patentees were unduly favoured. In the Patent Act there were provisions to prevent this inequality, but they were not adequate, and he hoped to bring about a better state of things."

So far, so good. We take this opportunity, however, now that an inquiry into the matter seems to be in progress,

to enlarge upon our remarks on the Patent Laws, and to point out some serious defects which were commented upon in a very able address delivered last month before the Manchester Section of the Society of Chemical Industry by Mr. Levinstein. After dealing with the subject of preliminary examination, to which the opposition, he said, principally arose from the Chartered Institute of Patent Agents—since a reform as to search would deprive its members of a lucrative part of their business—he declared that one of the main faults in our present patent system was that it did not confer a shadow of a secure title, and that a patent suit to establish such a title spelled ruin to all but capitalists. Mr. Levinstein further remarked that our Patent Laws encouraged the taking out of "bluff and bogus patents," and dwelt upon the injury done by our system to the British taxpayers. This injury arises from the fact that we grant annually about 9,000 monopolies in excess of those granted by Germany, which means that there are thousands of articles protected in Great Britain for which the Government of our commercial rivals refuse patents. The articles so protected are manufactured in Germany, without any restriction or royalty, at a cost considerably lower than they could be manufactured here. The German manufacturers, therefore, supply the British demand at their own prices without adding a penny to the Imperial or local taxation.

Most of the injury done to British taxpayers by our patent system is the result of the disconformity existing between our Patent Laws and those of foreign nations. Thus, for instance, in Germany, France, or Austria, the patentee, during the life-time of his patent, may take out supplementary patents relating to improvements. These additional patents, however, expire simultaneously with the main patent. In England such additions are not provided for. The foreign inventor, consequently, takes out ordinary patents for them, and the result is that his invention continues often to have a monopoly for many years yet after it has expired in his own country.

Mr. Ritchie, no doubt, is in earnest in his desire to devise a reform of our Patent Laws, but our Governments are unfortunately not inclined towards radical changes even when they are obviously needed, and unless we keep on urging them again and again, notwithstanding these promises, they are apt to dole out improvements in such small doses as to be of but little real practical value.

**Steel Railway Carriages . . .**

A FEW years ago some isolated examples of iron or steel railway carriages were to be seen on one or two of our English lines, but they have apparently disappeared entirely. The value of such vehicles in case of collision would probably be very great, to say nothing of the advantages derived from the comparatively small amount of inflammable material used in construction. Discussion relative to this very point has recently occurred in the United States, and it appears that steel cars are now being very largely used for goods traffic on the Baltimore and Ohio Railroad. In fact, when the property was turned over to the owners after reorganisation under the hands of a receiver, about 6,000 nearly new steel cars were included in the rolling stock. The chief of the Carriage Department of the Pittsburg and Western Railway, which is a branch of the Baltimore and Ohio line, has had many of the steel cars sent to him for repair after accidents of various kinds, and his views are therefore of considerable value. In one case, the car went over the bank of a siding and fell upon the main line, where it was under a load of 100,000 lbs. of broken stone which came down from the siding. The sides of the car were indented about 18 in., and a good many of the fittings were damaged, besides which some injury was done when the car was being removed from the main line so as to permit the resumption of traffic. It seems that by the judicious use of hydraulic jacks, and of hammering, the sides were straightened, and the total cost of repairs only amounted to $38.97. If a similar mishap had be-

fallen an ordinary goods truck there would certainly have been nothing but fire-wood and scrap-iron left. Cars of this kind are made of pressed steel, and they possess the advantage of great lightness and immense strength. Their carrying capacity is more than that of wooden trucks, and being practically indestructible they are more economical in every way. Even a single car in a train acts as a sort of buffer to the rest in case of accident. There are many reasons why our British manufacturers and railway companies should give consideration to this method of construction. If they do not, we shall probably hear at no distant date that American firms are beginning to book orders for steel railway cars, as they now do for electric and other locomotives.



**Dust Destructors and the Utilisation of their Heat . . .**

THERE is a tendency at the present time amongst engineers to cause the fire of any generator of steam to act immediately on the heating surfaces. In the older types of dust destructors this principle is not so rigidly applied as one might wish. So not unfrequently the hot gases require to travel a considerable distance from the grate before they reach the heating surfaces of the generator. When the hot gases travel far before they come in contact with the heating surfaces there is always a loss of heat, and that loss may be measured by the distance between the grate and the heating surfaces. But there is another fault in having this kind of arrangement, whereby the hot gases do not come immediately in contact with the hot surfaces. That fault is a serious loss of temperature of the gases. In the valuable experiments made by Mr. Blechynden he showed that the quantity of heat transmitted through a heating surface to water per hour depended on the square of the difference of temperature between the hot gases and the water. If, therefore, the distance between the fire grate and the heating surface be a great distance, and we suppose that the temperature of the hot gases, when they reach the heating surface, be half what it is of the same gases over the grate, then the quantity of heat transmitted through the heating surfaces will only be one-quarter per hour of what it would be were the heating surfaces of the generator situated immediately above the grate. We are glad, therefore, to learn that advantage will shortly be taken of this principle, and that a dust destructor will be made which is arranged so that its heating surfaces will be directly above the gases in their hottest condition. In this arrangement there will be three grates, one in the middle, and one on each side sloping towards it. The water-tube generator will be immediately above the middle grate. The refuse will be first let down on to the side grates, and there it will start being consumed. As this refuse continues to be consumed it will work down on to the middle grate from both sides, and on that middle grate will be in a state of incandescence. The smoky unburned gases which rise from the refuse in the side grates will be led in their path to the chimney over the incandescent refuse on the middle grate, and will be there consumed, and rise directly from the middle grate up through and amongst the tubes of the generator. It is thought that an easy evaporation of 2 lb. of water per pound of refuse will be obtained by the new arrangement, and that not by using selected town refuse, but by using ordinary town refuse on the grate.

Amongst the famous essays written by Emerson is one on the *Times* newspaper. In that essay we are told that some newspapers lived by copying matter out of the *Times*, while others lived by criticising or opposing whatever it advocated. We are not, therefore, very surprised to learn that one of the smaller monthly magazines has discovered a slip of the pen made in this magazine, and that it makes the most of this slip in its first leading article. In a leaderette in our February issue we made the statement that Mr. Russell of Shoreditch claimed an evaporation of ·99 lb. of water per lb. of ordinary refuse consumed per hour. In another leaderette in the March issue we further said: "The value of each pound of refuse as an evaporator was about equal to one-ninth of a pound

of coal." We followed this up by stating that it was claimed for the Rochdale destructors that an evaporation of 1·78 lb. was obtained per pound of refuse, while at the Salford Sewage Works the claim was 2·38 lb. of evaporation per pound of refuse. With these numbers before us we concluded that the one was $1\frac{3}{4}$ times and the other $2\frac{1}{4}$ times better than Mr. Russell's results. In another place we, meaning to say that the refuse was about equal in evaporative value to one-ninth of a pound of coal, said by a slip of the pen that it had an evaporation of one-ninth of a pound of water, and the slip has been made the most of in the manner described by Emerson and referred to above. There are other misstatements made and deductions drawn on these, supposed to be amusing and clever, which we might deal with, but our space for the advertisement of other journals is limited.

**Engineers in the British Navy . . .**

NOTHING can be more obvious than the absurdity of conferring upon our engineers in the Royal Navy a so-called "relative" rank, which is a mere fiction, and depriving them of the actual rank of officers, which alone would endow them with the authority they absolutely need over those who work under their supervision; and equally obvious is the lamentable condition of things in our navy, arising from the dearth of naval engineering officers, by which the safety of our most costly war-vessels is jeopardised. Mr. D. B. Morison, Vice-President of the Institution of Marine Engineers, in his paper read at the general meeting of this Institution, at Newcastle-upon-Tyne, on March 3rd, very ably discusses these points. He demonstrates that our great mail steamers carry more than three times as many engineers as is the case regarding war-vessels about equal with them, so far as i.h.p. is concerned, although the engineering work to be performed on merchant vessels is far less complicated and important than similar work in the navy. He shows that the engineer-officers in the navy are over-burdened with duties, and that junior officers frequently are called upon to undertake senior responsibilities; he enumerated the many varied and important duties that a naval engineer is called upon to fulfil, and shows that on such fulfilment depends in a very great measure indeed the success in battle, and he justly comments on the absolutely anomalous condition of things, by which the naval engineer is treated as a civilian, and has not the slightest authority to enforce his orders on his subordinates, but must, in case of their delinquency, appeal to some officer, and might, although a highly educated official, find himself in some extreme emergency placed in the position of having to obey orders of a gunner or a boatswain.

The United States, where, until lately, the same conditions existed as in our own navy, have grasped the dilemma by the horns, and under the Personell Bill, which became law on March 3rd, 1899, the officers of the Engineer Corps are transferred to the line and given new commissions as line officers with *actual* rank, thus doing away once for all with the meaningless fiction of *relative* rank. This change is a real landmark in the history of naval progress, and cannot but act beneficially upon the efficiency of the United States navy. It is a great pity that our own Admiralty has not seen its way to follow this good example. Certain changes, it is true, have been made regarding the promotion, status and pay of engineer officers, but what do they amount to?

The number of chief-inspectors of machinery is increased from five to eight, and that of inspectors from eight to thirteen. This is at least some improvement, but we doubt whether even this increased number will be adequate to cope with the many and steadily growing inspecting duties. As regards the status of naval engineers, the Engineer-in-Chief has been given the "relative" rank of rear-admiral, chief-engineers are to rank "relatively" with lieutenants of and above eight years' seniority, while engineers lower than chief-engineers will have "relatively" the same rank with lieutenants of less than eight years, instead of, as heretofore, ranking after them.

But of what real use is this "relative" rank to the engineering officers? The status of our engineers on board ship remains practically unchanged, and though on their efficiency depends the safety of the vessel and, in a great measure, the result of a naval engagement, they continue to be treated as civilians, permitted to masquerade before the world at large as officers. However high their intellectual qualifications or their practical skill they remain in authority below a non-commissioned officer.

Let us hope that the Admiralty in the near future will realise the futility of half-measures in this matter, and make a radical change that alone can dispose of a problem in which, as long as it is unsolved, lurk real dangers for the efficiency of our navy.

### San Francisco Harbour . . .

NAVIGATION is at present inconveniently hampered in San Francisco Harbour by the presence of various rocks and shoals, the most awkward and dangerous of which are situated between Alcatraz and Angel Islands. The channel is thus divided into two portions, and dangerous currents are established in a part of the bay much used by passenger steamers and other vessels. After careful enquiry, the State Government has decided to undertake the removal of the Arch and the Shag rocks, together with two adjoining shoals comprising some ten acres of soft conglomerate. A commencement has already been made upon the Shag rock, which is very little above the water level at high tide, and is irregularly surrounded by a shoal extending about 180 ft. in each direction. It is the intention of the authorities to clear away so much of the misplaced material as may be necessary for the establishment of an average depth of 30 ft at low water. For this purpose a mast, nearly 70 ft. high and 2 ft. square, has been stepped into the top of the rock, being held securely by guy-lines anchored to the bottom of the shoal. A revolving platform, 180 ft. long by 30 ft. wide, is suspended by ropes from the upper end of the mast, and will serve as a stage for the operation of drilling-tools, motive power for which will be furnished by a steam engine fitted upon a barge anchored close to the platform. Dynamite is to be placed in the holes, and only a few charges will be ignited at one time. There will, therefore, be no grand explosion similar to that occurring when the well-known obstruction was removed from the entrance of New York Harbour. It is hoped that the whole work will be completed within about two years.

### The Electrical Power Bills . . .

THE Electrical Power Bills of this session, *i.e.*, the Lancashire, Durham, South Wales and Tyneside Bills, after passing their second reading, have been referred to a select committee, and are to be considered on the 3rd of the present month. They were attacked on two main grounds, the first being that they constituted an infringement on what the municipal bodies consider to be their rights and privileges, while the second was the assumption that they constituted a new and formidable monoply. As regards the first, the question may be open to discussion, but as regards the second, anybody who has read the bills will see that it is unfounded, for the promoters have certainly been at pains to show that there is no intention of creating such a monoply. There is, therefore, no cause for apprehension as regards the creation of monopolies by passing these Bills, and the real issue will remain between the privileges claimed by the municipalities and those insisted upon by the supporters of private enterprise, which, until quite recently, has been recognised as the very root and source of Anglo-Saxon civilisation. As regards the general aspect of this issue, we shall have to make a few remarks further on, but, as regards its special aspect, in the case of supplying electricity in bulk, the point is, whether such a supply can be furnished with greater advantage to the public by a company or by the municipalities, providing the latter are able to furnish it at all.

The principle that there should be no obstacles permitted to block the supply of electricity generated at one place for use somewhere else, even where enormous areas are concerned and the traversing of neutral intervening ground is involved, as long as the community at large is benefited thereby, was accepted last Session by a joint committee of both Houses, and there is good reason to hope that the principle involved will, at the hand of Sir James Kitson and his colleagues, receive the careful attention that, owing to its importance, it deserves.

### The Backwardness in Electrical Power Supply

Few persons, except those who are especially concerned in electrical matters, seem to realise how very great is the importance of electric power supply for industrial progress, and how far we are behind our competitors in this regard. We do not refer to electric traction merely, for, as we have said in our last issue, the retardation in the extension of electric tramway lines has perhaps not been all loss, and there are satisfactory signs that we are going to make up for lost time—though it will require no small amount of energy to restore some kind of equilibrium between the more than 15,000 miles of electric traction in the United States, the 2,000 miles in Germany, and the 500 miles, more or less, in our own country. What we wish to point out at present is our inferiority as regards the use of electricity for manufacturing purposes. It was by steam power that our industries were built up, and upon steam power we continue to rely almost exclusively; there has, however, meantime been going on a radical change of late in other countries as regards the form of energy used for industrial objects, and steam power is losing rapidly its paramount importance.

### Electricity v. Steam . . .

The average price of power supplied by coal-generated steam may be estimated at from £25 to £30 per horse power *per annum*; while on the European Continent and in the United States the same amount of power may be obtained from electricity at from £5 to £10 annually (the average unit costing 1*d.* and less). Can anybody doubt that our over-conservative adherence to steam power seriously endangers our industries? Sir William Harcourt's emphatical statement in Parliament that "he looked forward to this question of electricity and electric supply as the great question of the future," will find an echo in the heart of all those who have carefully considered the problem.

This being the case, should we not welcome a measure such as the South Wales Electricity Distribution Bill, for instance, which provides for the supply of electricity over an area of a thousand square miles at a maximum price of 2*d.* per Board of Trade unit? Can the municipalities which try to place obstacles in the way of these Bills offer greater advantages to the public, and are they in the position to undertake the supply at all over such large areas where the authority is divided among many of them? This is the main question, aside from the question of the principle involved. As far as South Wales is concerned, no public authority so far has ever supplied electricity at a less price than 5*d.* in average per unit, and it does not seem likely that the municipalities could make a more advantageous offer than those above quoted. They certainly could not if each municipality were to supply the district merely under its direct jurisdiction, for a corporation supplying, say, 20 square miles, could not possibly compete in price with a body supplying 1,000 square miles.

But the supporters of municipalism propose that a collective control should be given to the various municipalities constituting the larger area. There are, however, natural limits which may be discerned at a mere glance, and in the present condition of society, at least, the joint enterprise of a number of corporations, with more or less varying self-interests, seems to be out of the question, and would, even at best, retard the development of electrical power supply, which, as above stated, has been delayed far too long already.

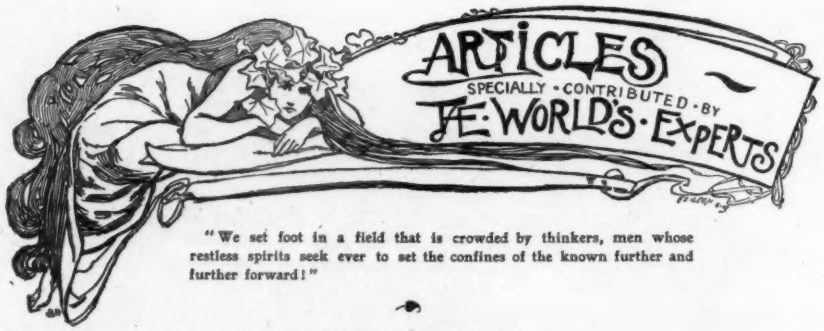
## Notes.

THE Government have declined to accede to the appointment of another commission to inquire into the extent or duration of our coal supplies. Many may have felt disappointed at this attitude of Her Majesty's Ministry, but they may console themselves with the knowledge that, as recent inquiries show, there is no danger of the supplies being exhausted before a great many years to come. The Argyll Commission, which reported on the subject 29 years ago, had some of their most important conclusions falsified by later knowledge. Sir Alfred Hickman, M.P., Mr. A. L. Stevenson—whose views may undoubtedly be taken as authoritative—Mr. Longden of the Stanton Coal and Iron Company, and Mr. G. Blake Walker, of the Wharncliffe Silkstone Collieries in Yorkshire, all of them experts, seem to agree, as their letters to a contemporary show, that Great Britain's stock of coal is far greater than it has generally been assumed to be. The only subject which might advantageously become one of official inquiry seems to be, what effect an export duty on coal might have on our industries?

SOME time ago great hopes were based upon the use of the X-rays for the testing of coal with the object of determining beforehand the quantity of ashes which the samples would yield. M. F. Kotte of Duisburg, an authority on the subject, has published in *Stahl und Eisen* a series of experiments, made in order to see whether these hopes were well founded, and comes to the conclusion that the Röntgen rays do not reveal the percentage of ashes that will remain after burning, and consequently that, however interesting such coal tests may be from a scientific point of view, they are from a practical point "absolutely useless."

THE Acetylene exhibits, which at first were threatened with being relegated to the Vincennes annex, miles from the main body of the Paris International Exhibition, will, it now appears, owing to the exertion of M. Daix, find a more suitable installation. M. Daix, who was appointed by the Budapest Congress to look after the acetylene interests during the great fair, has applied to the municipality of the French capital to grant him a site near the Dôme des Invalides, on the Place Vauban and the Avenue Breteuil. He is busily engaged in forming a committee, unlimited in number and representing all nationalities, of exhibitors who undertake to pay for 10 square metres of space at the rate of 125 francs per metre, and to contribute besides a sum of not less than 1,250 francs, to form the nucleus of a guarantee fund. Twenty-four French and several foreign firms, including the Acetylene Illuminating Company of London and Foyers, have promised to support him, subject to the site being accorded. The intention is to erect two identical buildings, one for the French and the other for foreign exhibitors. It is to be hoped that these intentions will be realised, since a truly representative exhibition of all that refers to this new and steadily growing industry cannot but be instructive. As the General Committee of the Exhibition includes M. Berthelot as Honorary President, and all the greatest authorities on acetylene, the jury will be one whose approval must carry the greatest weight.

THE quarrel between the rival Incandescent Companies has degenerated into that most unprofitable of all strife—a paper warfare. In the interests of British trade, to say nothing of the shareholders concerned, it is a pity that so much money should be devoted to purposes the futility of which must be apparent to everyone who has attempted to weigh the *pros* and *cons* of the matter. It should not be difficult for the respective chairmen to arrange a permanent and mutually satisfactory conciliation, or at least to exercise a rational amount of forbearance while the crucial matters are *sub judice*.




"We set foot in a field that is crowded by thinkers, men whose restless spirits seek ever to set the confines of the known further and further forward!"

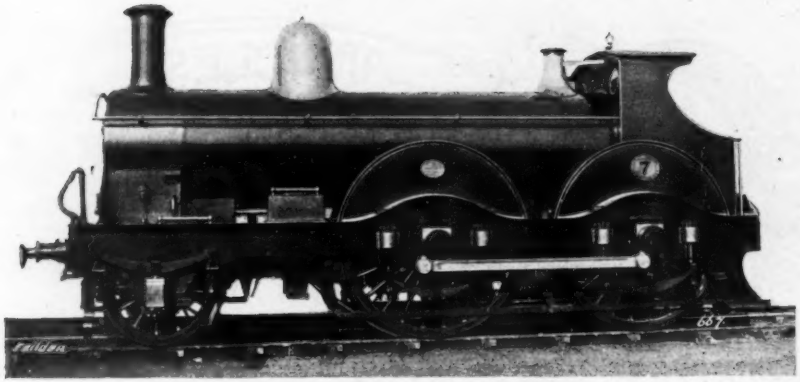
# Compound and Four-Cylinder Locomotives in England and France.

By CHARLES ROUS-MARTEN.

*(Continued from page 376.)*

THE de Glehn compounds are subdivided into two classes. In the one case the engine has four coupled driving-wheels, 6 ft. 7 in. to 6 ft. 11 in. in diameter; in the other, six coupled driving-wheels, 5 ft. 7 in. to 5 ft. 9 in. in diameter. In each case there is a four-wheeled leading bogie. The six-coupled class is larger and heavier and of course more powerful than the other, although somewhat less suited to the highest speeds.

I illustrate the latest type actually at work of the four-coupled on the Chemin de Fer du Nord. With regard to this class I may say that for these engines certain leading dimensions were adopted at the outset and have remained ever since unchanged. The diameter of the four driving-wheels was fixed at 6 ft. $11\frac{1}{4}$ in. with new tyres. The length of the boiler is 12 ft. 10 in. between tube plates. The two high-pressure cylinders are 13·4 in. by 25·2 in., the two low-pressure cylinders are 20·9 in. by 25·2 in. These dimensions have never been varied, but continue the same in all the sixty engines of the class. The first two engines (Nos. 2.121 and 2.122) had tubes of the ordinary kind, giving a heating surface of 1,200 sq. ft.; the next fifteen (Nos. 2.123—2.137), built two years later, were fitted with Serve tubes, affording a heating surface of 1,553 sq. ft., to which has to be added 117 ft. for the fire-box, making a total heating surface of 1,670 sq. ft., as against 1,317 sq. ft.—including fire-box—in the earlier engines. In 1895 twenty more of the locomotives were constructed. These (numbered 2.138 to 2.157) were in all respects but one identical with the previous batch. That single exception was that in both of the earlier sub-classes the steam pressure in the boilers was 198·7 lbs. to the square inch. In the new engines the pressure was increased to 213 lbs. In 1896 the fourth sub-class of these engines came out, the first being numbered 2.158. The new departure consisted in augmentation of the boiler power, the heating surface of the tubes being increased to 1,768 sq. ft., and that of the fire-box to 122 sq. ft., or a total of 1,890 sq. ft., while the fire-grate area, which had been 22 sq. ft. in the earlier engines, was enlarged to 24 sq. ft. As the augmented power involved increased consumption of fuel and water, a larger tender was provided running on two four-wheeled bogies, and capable of carrying 4,000 gallons of water and a pro-



GREAT WESTERN FOUR-CYLINDER TANDEM COMPOUND EXPRESS ENGINE NO. 7. DIAMETER OF COUPLED WHEELS, 7 FT.; CYLINDER DIMENSIONS UNKNOWN (BROKEN UP).

portionate supply of fuel. The high-pressure cylinders are placed outside to the rear of the leading bogie and drive the hinder pair of wheels, which have a straight axle, while the low-pressure cylinders are inside, and drive the forward pair of 6 ft. 11¼ in. wheels by means of a cranked axle.

What may be termed a fifth class (numbered 2.161 to 2.180) has slightly larger fire-box and steam-chest, and jacketed steam pipes, while the weight in working order is nearly 51½ tons, that of the four preceding sub-classes having gradually developed from 47¾ tons to 48½, 49 and 50½ tons loaded.

Among other good points which may be noted in respect of the details of this class of engine, are (1) the provision for direct admission of steam to the intermediate reservoir; (2) a three-way valve by means of which the exhaust from the high-pressure cylinder can be discharged into the atmosphere, thus avoiding an excess of back-pressure; (3) the setting of the high-pressure and low-pressure cranks on each side of the engine at an angle of 162 deg. to one another, which renders the work of starting far easier. It is, indeed, in *starting* that these locomotives are so pre-eminently efficient. Being able to turn a full head of high-pressure steam at 213 lbs. to the square inch not only into the relatively small high-pressure cylinders, but also into the large low-pressure cylinders, and with the cranks so set as to avoid all approach to dead centres, these engines "go off"—as a veteran driver of the English Midland Railway expressed it to me after witnessing their performances—"like a shot from a gun."

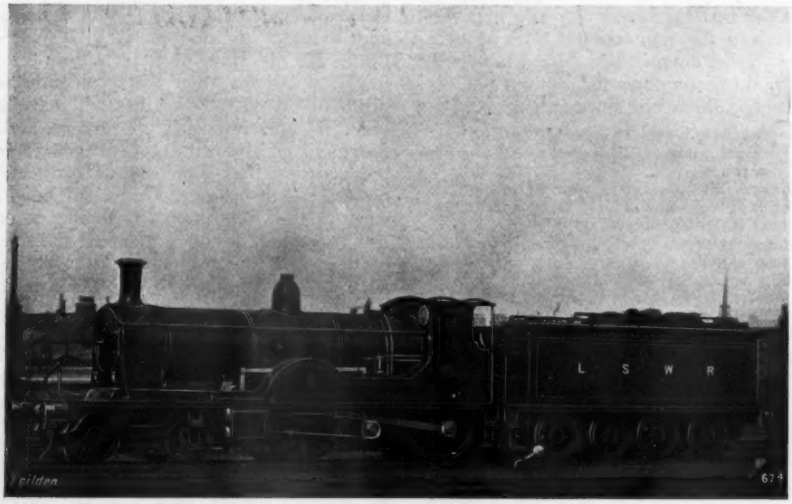
The four-cylinder compound engines of the ten-wheeled six-coupled type, as used on the Chemin de Fer du Nord, have vast boilers with 1,950 sq. ft. of heating surface; 24·4 sq. ft. of grate area; 13·8 in. high-pressure cylinders; 21·6 in. low-pressure cylinders, and 5 ft. 9 in. coupled wheels. The piston-stroke is the same as in the four-coupled type, 25·2 in. The weight of the engine in working order is 58½ tons. Manifestly, it possesses immense haulage power, but I have found its speed capacity also remarkable.

At this stage it may be interesting to quote M. de Glehn's own account of the *raison d'être* and genesis of these remarkable engines. In a letter to me he says:—"I should like to take this opportunity of stating my reasons for designing this type. On the Continent we were continually wanted to build more and more powerful engines, being at the same time considerably limited by the weight allowed us. Bigger and more powerful boilers meant more weight; the compound principle

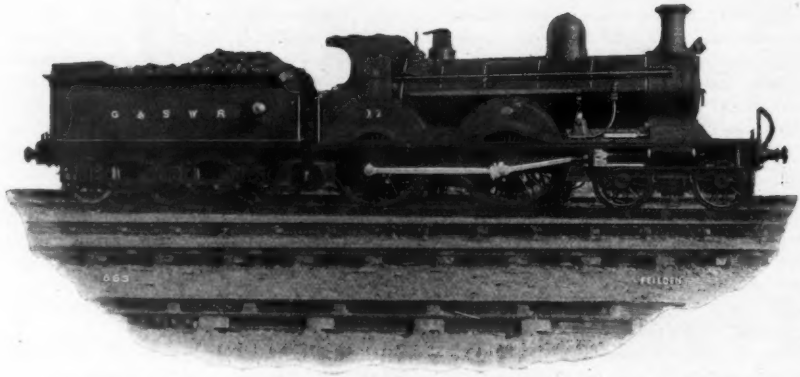
allowed me to use the steam more economically, and this was equivalent to having a larger boiler without more weight. I maintain that for the same total weight I can build a four-cylinder compound express, or six-coupled engine, 15 to 20 per cent. more powerful than an ordinary engine can be having the same total weight. High pressure can be better utilised with ordinary slide-valves, for the high-pressure valves are half equilibrated, having *on* them the full pressure and *under* them the receiver pressure; the whole work of the engine is better distributed over the whole engine, and you can give all the working parts proportionately much larger wearing surface. That it is, coupled with what I have first said about the valves, and what I say further on about the counterbalancing, which makes these engines require so little repairs in spite of the multiplication of parts and seeming complication. Increased attention is rightly being paid to the balancing of the revolving and re-reciprocating parts; the four-cylinder engines are far and away above all others in this respect, *so long, of course, as you keep the coupling rods.* Being able to work with direct steam in all the four cylinders, the starting is exceptionally certain and rapid. You see I have not said anything about fuel economy; this point is, of course, of some importance, but is generally of much less than that of *power*, steadiness of running, and repairs. Of course these engines are somewhat more costly to build, but not so much more as one would think at first sight, and less so than some of the simple engines (non-compound) which have been built to use high-pressure steam with Corliss or reducing valves."

This puts the matter so clearly as to need no comment on my part. Every engineer will recognise the force and truth of the views thus succinctly stated.

It is needless, and would be tedious, for me to specify in full the almost numberless little differences in detail and dimension among the engines of these types as built for the various French lines. The four-coupled engines, latest built for the Midi—Nos. 1751 to 1772—are slightly larger and heavier than those on the Nord. Those on the P. L. M. have 6 ft. 7 in.




LONDON AND SOUTH-WESTERN FOUR-CYLINDER NON-COMPOUND EXPRESS ENGINE NO. 720. D. DRUMMOND.
CYLINDERS (4), 14×26; DRIVING WHEELS 6 FT. 6 IN. (AS REBUILT).



GLASGOW AND SOUTH-WESTERN FOUR-CYLINDER NON-COMPOUND EXPRESS ENGINE, NO. 11. J. MANSON.
CYLINDERS: INSIDE (2) 14½×26, OUTSIDE (2) 12½×24; DRIVING WHEELS 6 FT. 9 IN.

coupled-wheels, and the "wind-cutters"—as useless as ugly, in my humble opinion. The six-coupled engines on the Est have 230 lbs. steam pressure. But in all essential respects there is but one type in each of these two classes throughout the whole of France, and also on certain Swiss and German railways as well.

For this year's Exposition in Paris the Chemin de Fer du Nord have ordered from the Société Alsacienne two gigantic editions of the four-coupled type of their four-cylinder compounds. I am indebted to M. de Glehn for a list of the chief dimensions, which will be as follow:—

| | |
|---|---|
| High-pressure cylinders (2), diameter | 13½ in. |
| Low-pressure cylinders (2), diameter | 22½ in. |
| Stroke of piston ... ... ... | 25½ in. |
| Diameter of driving-wheels (4-coupled) | 6 ft. 9 in. |
| Diameter of bogie-wheels (4) ... | 3 ft. |
| Diameter of trailing-wheels (2) ... | 4 ft. 8 in. |
| Length of boiler ... ... ... | 16 ft. 8 in. |
| Diameter of boiler ... ... ... | 4 ft. 10 in. |
| Heating surface, Serve-tubes, 2,108 sq. ft. | |
| ,, ,, fire-box 167 sq. ft. | |
| Total heating surface ... ... | 2,275 sq. ft. |
| Area of fire-grate ... ... ... | 29·5 sq. ft. |
| Pressure of steam per sq. in. ... | 213 lbs. |
| Weight of engine in working order | 63 tons |
| Weight of tender ,, ,, | 45 tons |
| Total weight of engine and tender ... | 108 tons |
| Weight on driving-wheels ... ... | 33 tons |
| Fuel capacity of tender ... ... | 5 tons |
| Water ,, ,, ... ... | 4,500 gals. |

It will be noticed that these two engines have considerably larger dimensions than their predecessors in all but one main respect, viz., the driving wheels are about 2½ in. less in diameter. This reduction will give enhanced tractive force, yet will in no degree impair the speed-capacity of the locomotive, while it will enable the coupled wheels to be more conveniently placed in front of the fire-box. The increased size of the fire-box and of the boiler will be noticed at once and will be rendered all the more observable through the extra pair of carrying wheels being added under the foot-plate. To judge from the drawings kindly shown me by M. de Glehn when I was recently at Mulhausen, the new engines will have a very fine and imposing appearance, and, judging from my own experiences of their predecessors, they should be as swift and powerful as they look. One is to be on view in the Exposition, while the other will run some of the principal expresses on the Nord line. Thus visitors will be able not only to inspect the one at their ease, but also to note the actual performances of the other. There are rumours of acceleration for next year, even in advance of the present remarkable timings of the Nord Railway, which already has no fewer than forty-five express runs booked at average speeds of 50 miles an hour and upward from start to stop, 25 of these being at or over 52 miles an hour. 14 over 53, 11 over 54, 8 over 55, 5 over 56, 3 over 57, and 1 at 60·5 miles an hour

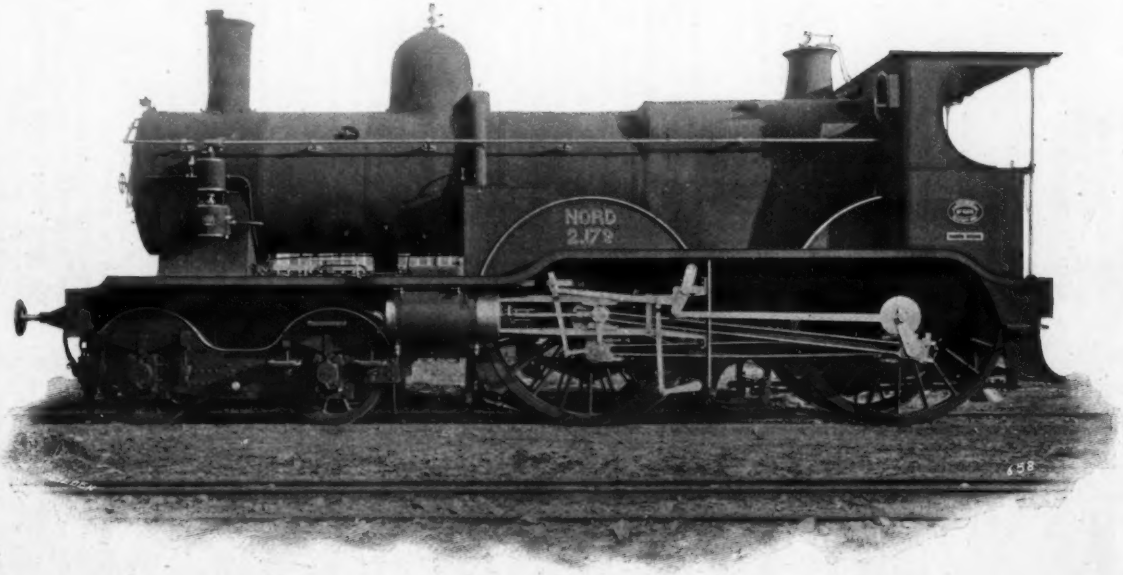
from start to stop. Unhappily there is nothing at all to compare with this in Great Britain, where, with the exception of the two short runs on the Caledonian for 32½ and 33 miles respectively at 59 and 56½ miles an hour, we have not now a single regular train timed as fast as 56 miles an hour, and, indeed, only six—three on the Caledonian, two on the Great Northern, and one on the North-Eastern—timed at 55 miles an hour. The case stood otherwise three years ago, but since then we have retrograded while the French and Americans have advanced. This is a fact which must be noted with regret, but cannot be honestly disputed or questioned.

Reviewing, as a whole, the question whether it be advisable or not to adopt the compound principle for locomotives, I think that the entire gist and inwardness of the matter may be found in the extract from M. de Glehn's letter which I have quoted. The scope of the 4 ft. 8½ in. gauge is limited. The scope of the loading-gauge is severely limited in this country, much less so in Europe, still less in America. But in each case the rail-gauge and the loading-gauge constitute two absolute and impassable limits beyond which enlargement of dimensions cannot extend. If then augmented power be called for, as we know is the case daily with the rapidly increasing traffic, when once we have reached the extensional limits thus imperatively imposed, the question arises: How is any further augmentation of power to be compassed?

Certain manifest resources at once suggest themselves. In most cases the driving-wheel diameter can be reduced. Mr. J. A. F. Aspinall, when showing me the pioneer of his new monsters, the "1400" Class of the Lancashire and Yorkshire Railway, remarked that with that engine he had reached the utmost limit of dimensional extension possible on the present gauge of rails and loading. No doubt that is so if we concede the necessity or advisableness of using driving-wheels of such large diameter as 7 ft. 3 in. —the largest coupled wheels in existence, with the exception of those under two experimental engines. But I cannot see the need of such large wheels. I have the highest admiration for Mr. Aspinall's great ability and for the engines he has designed, but I have never been able to convince myself that 7 ft. 3 in. wheels could be so useful, especially on such a line as the Lancashire and Yorkshire, as smaller ones would be. Obviously, every inch added to the wheel-diameter is *pro tanto* a loss of power; nor do I regard the reduction in piston-speed and in the velocity of the reciprocating and revolving parts as sufficiently beneficial to compensate for the loss of tractive force. Neither can I admit that any superior swiftness is gained by having a larger wheel. With one solitary exception—in special circumstances—the highest speeds I have ever recorded, and that on several occasions, have been attained by engines with 6 ft. 6 in. wheels. So fast a service has never been run regularly in this country as that of the Caledonian in 1896, which was wholly performed by the engines with 6 ft. 6 in. wheels built by Mr. J. F. M'Intosh. I am well aware of all the advantages claimed for larger wheels, but with due deference to the many distinguished engineers who advocate the greater diameter I must maintain, as the result of a vast number of careful observations, that these advantages are mainly theoretical and do not show themselves in actual practice. On the other hand, the enhanced tractive power afforded by smaller wheels does show itself most unmistakably in the actual and definite results.

If then we concede the feasibleness of reducing driving-wheel diameter to 6 ft. 6 in., or even 6 ft., then there is room yet for a boiler even bigger than the colossal one which Mr. Aspinall has given to "No. 1400." But, at the same time, it may be open to serious doubt whether any further expansion of the boiler dimensions would be judicious.

A second plan by which some augmentation of power would be feasible is an increase of the steam-pressure. Here we are much behind some other countries. We have slowly and cautiously crept up from 140 lbs. in 1884 to 200 lbs.—in a very few cases—in 1899. In the vast majority of instances, 150 or 160 lbs. is a far more common maximum, and 175 lbs.




CHEMIN DE FER DU NORD, FRANCE. LATEST TYPE OF FOUR-CYLINDER COMPOUND EXPRESS ENGINE, NO. 2.179, DESIGNED BY MM. DE GLEHN AND DU BOUSQUET; BUILT BY THE SOCIÉTÉ-BELFORT. CYLINDERS: HIGH-PRESSURE (2), 13⅜ IN.; LOW-PRESSURE (2), 21 IN.; PISTON-STROKE 25½ IN.; DIAMETER OF COUPLED WHEELS, 6 FT. 11½ IN.

s, as a rule, deemed the highest pressure desirable. But on the European Continent 213 lbs. has long been in common use with unquestionable advantage, and even 230 lbs. is given to some of the newest locomotives. Here then exists one other potentiality.

The four-cylinder non-compound method must be regarded rather as an extended development or modified distribution of power already existing than as a creation of fresh force, such as a larger boiler or higher pressure affords. It is being tried by only two of our leading engineers—Mr. D. Drummond, of the London and South-Western, and Mr. J. Manson, of the Glasgow and South-Western. Each has tried only one engine, so far. I illustrate Mr. Drummond's London and South-Western engine (No. 720), which has two outside cylinders driving the rear pair of 6 ft. 6 in. wheels, and two inside, which drive the front pair of 6 ft. 6 in. wheels. The heating-surface, including that of the water-tubes, is 1,750 sq. ft.; steam pressure 175 lbs.; piston-stroke 26 in. All four cylinders are of identical capacity. Originally they had a diameter of 16½ in.; this was found too large a cubic capacity for the boiler to keep supplied with "live" steam, and so they were successively lined up to 16 in., 15 in., and finally to 14 in. — as they remain at present. The engine, as rearranged, appears to do very good work; and I have personally witnessed one or two excellent performances.

The design has many good points, including some details which do not strictly belong to my present subject. In its main principle, "No. 720" is what may be termed a "double single-wheeled" engine, like Mr. Webb's three-cylinder compounds, as each pair of wheels operates quite independently, while the aggregate adhesion weight on the two pairs amounts to 37¾ tons. It is contended, of course, that by this method the advantages of coupling are obtained without the drawbacks. As I mentioned in my previous article, I do not share this opinion. I admit that the method affords the adhesion power of the coupled plan, but I consider that there are drawbacks attaching to the employment of what are practically two independent engines fed by a single boiler, although I think that this is less objectionable than when the engine is compound, and therefore dependent upon the steam exhausted from its high-pressure cylinders to supply its low-pressure cylinder or cylinders. My experience has led me to the conclusion that the disadvantages of coupling have been much over-rated, and that when heavy loads have to be pulled the plan is virtually unavoidable. At the same time, I freely recognise the advantages possessed by Mr. Drummond's four-cylinder system in respect of better balancing of the reciprocating and revolving parts. His design may be summed up as consisting in the combination of two independent high-pressure single-driver engines—on one frame and with one boiler. But he has also largely enhanced the capability of that boiler by supplementing its ordinary heating-surface with the fire-box water-tubes, which naturally possess far greater capacity in respect of steam generation than the regular boiler-tubes, whose efficiency diminishes at a rapid rate with every foot of distance from the fire-box. The water-tubes, on the other hand, are in the heart of the intensest combustion and so should represent relatively very large power of vaporisation.

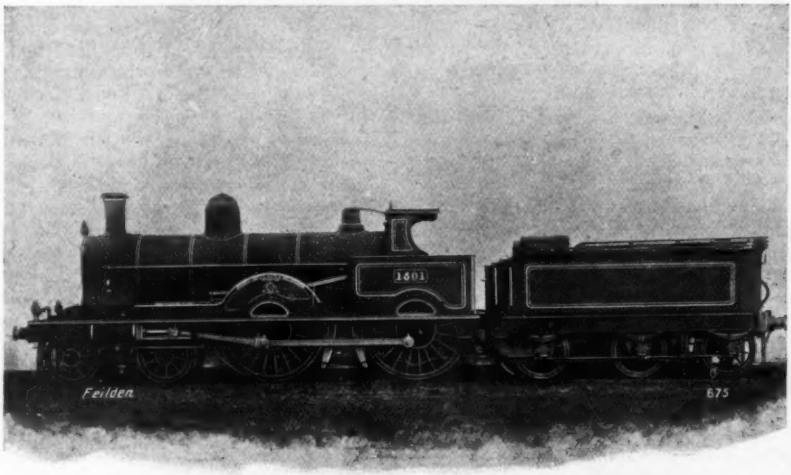
In my earlier article I referred to these water-tubes, which had also been tried on the North-Eastern, and remarked that in some instances serious trouble had been experienced in keeping the water-tubes thoroughly tight. I may say that my remarks had reference solely to the North-Eastern experiment, these tubes being used in the converted compound (No. 1619), and Mr. W. Worsdell had informed me that the result had not proved entirely satisfactory, for the reason just given. But Mr. Drummond assures me that he himself has obtained most valuable advantages through the employment of the fire-box water-tubes as fitted in his four-cylinder engine (No. 720) and in his two-cylinder type (702 class), while he has not had any trouble with leakage. I may say that personally I have seen his engines thus fitted on the system which

he has specially patented do admirable work, alike as to speed and as to haulage. I fully expect to see this plan come into extended operation as its benefits become more and more widely known through the demonstration of practical experience.

As to Mr. Manson's four-cylinder locomotive, I cannot give much information, as I have been unable yet to study personally its working. It is designed on a much smaller scale than Mr. Drummond's engine. The outside cylinders are 12½ by 24, the inside 14½ by 26. All four drive a single shaft, as in the case of Mr. Webb's new compounds, and, like them, but unlike Mr. Drummond's engine, the two pairs of wheels are coupled. Mr. Manson tells me that the engine, No. 11 (see illustration) has done very well hitherto, and that he purposes building others of the same type.

Of Mr. Webb's four-cylinder non-compound, originally named "Iron Duke," but now converted into a four-cylinder compound named "Jubilee," I need say little, except that the outcome of the experiment was exactly what I anticipated when I noted that its dimensions were the same as those given to the corresponding compound. The boiler, with only 1,400 sq. ft. of heating surface, could fill easily enough the one pair of high-pressure cylinders in the compounds, but could not fill the two pairs of the non-compound. And so the type was permanently abandoned.

Thus we arrive again, by this different mode of review, at the same point as before, viz., that so tersely and forcibly put by M. de Glehn—that the most effective method of augmenting our power within the limits set by rail-gauge and loading-gauge to our possibilities of dimensional expansion is to use the steam more economically—in other words, to use it twice over instead of exhausting it while it still retains large work capacity—or again in other words—to adopt the compound principle. This next involves a selection among the various systems. After long, careful, and wholly impartial observation, based on practical and experimental work, I have come to the conclusion that while the two-cylinder and three-cylinder methods—especially with coupled engines—give fairly good results under favourable conditions, and are particularly



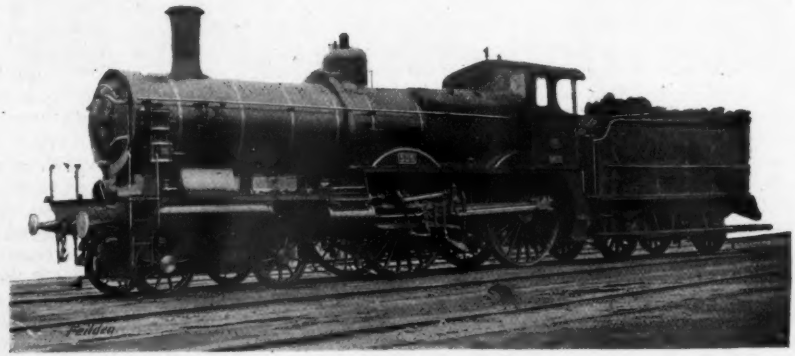

LONDON AND NORTH-WESTERN FOUR-CYLINDER COMPOUND EXPRESS ENGINE "JUBILEE." F. W. WEBB. CYLINDERS: HIGH-PRESSURE (2), 15×24; LOW-PRESSURE (2), 20½×24; DRIVING-WHEELS, 7 FT.

well suited to goods and mineral work, they are by no means so well adapted to express-train service, notwithstanding the brilliant performances they often have given, and are wholly unsuited to that class of suburban duty which involves frequent stoppings and startings. On the other hand, the four-cylinder system of compounding is free from almost all the defects of the other plans, and has numerous merits of its own in respect of better balancing of reciprocating and revolving parts, while it enables a large increase of power to be secured without any proportionate augmentation of weight or expansion laterally or vertically.

The conclusion at which I have arrived is, therefore, that the British locomotive of the future will be, and must be, of the four-cylinder compound type if the perpetual growth of the traffic is to be overtaken, and if this country is to hold her own with France and America in respect of speed. If I approached this question originally—fifteen years ago—with any prejudices at all, they assuredly were adverse to compounding for express work. But I have steadily watched the course of events, and have tested every system that has yet been tried to any material extent, either in Great Britain or in France. I have accumulated a voluminous collection of elaborate observations and of equally voluminous deductions from my experience. And the outcome is a verdict in favour of compounding, provided (1) that four cylinders are employed with ability to use high-pressure in all cylinders at starting, and (2) that the driving-wheels are coupled. Whether the abreast or the tandem cylinder-position, or the Vauclain double cross-head plan, whether the Webb, or the de Glehn, or the Vauclain system will find general and permanent adoption, I do not presume to predict. Time will show.

My illustrations of the following engines are reproductions of photos by Mr. F. Moore, 102A, Charing Cross Road, London, W.C. :—London and South-Western, No. 720; Great Eastern, No. 230; London and North-Western, "Teutonic," "Henry Cort," "Jubilee," and No. 2539; North-Eastern, Nos. 666, 1324, and 1517; Glasgow and South-Western, No. 11.

C. Rous-Marten



# The Tramway System of Glasgow:

## Transition from Horse to Electric Traction.

By BENJAMIN TAYLOR, F.R.G.S.

❀ ❀ ❀

MR. BENJAMIN TAYLOR for many years has occupied a leading position among Scottish journalists; has made a special study of industrial, social, and economic subjects, and figures conspicuously as a contributor to "The Nineteenth Century," "The Fortnightly Review," the leading London weeklies, and to the foremost American magazines and reviews. His articles on the Municipal aspects of the Tramway System have attracted world-wide attention and been extensively quoted.

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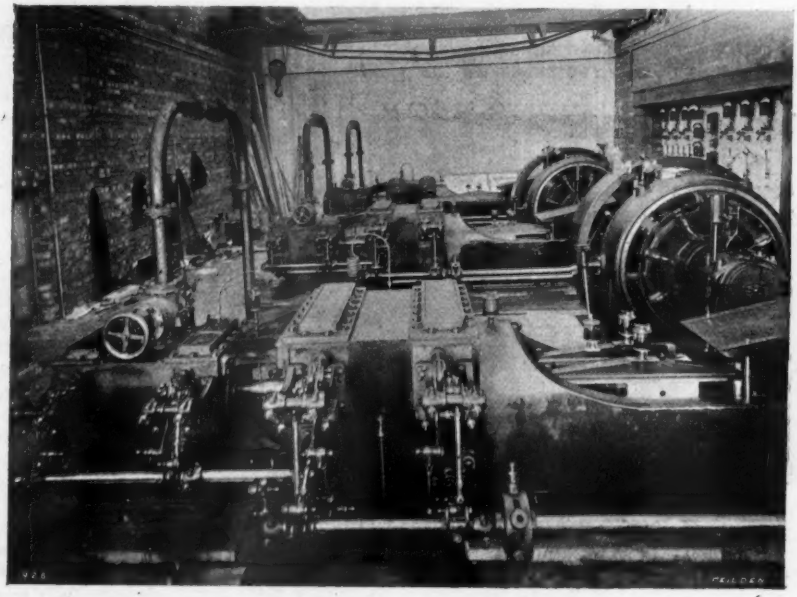
THE Glasgow Tramway System has several claims to special attention in a journal devoted to the study of mechanical invention and industrial progress. It is, for instance, the largest system using horse haulage in the United Kingdom. It is the only system under municipal management that has shown anything like a commercial profit. And it is at present in a state of transition to haulage by electric power on an extensive scale. Moreover, the Glasgow Tramway System is at one and the same time an example of municipal backwardness and municipal foresight. It was not the Corporation of Glasgow that first began tramway enterprise in that city. Away back in the "booming seventies," when the tramway mania was spreading over the land (in a somewhat less violent form than that of the railway mania of King Hudson's days), certain wise men came out of the South, and taking their walks abroad in the Second City, saw that it was very good—for a tramway deal. Certain other wise men, however, did the same, and so it came to pass that two separate syndicates, both hailing from London, applied to Parliament for power to lay down and operate tramways in the streets of Glasgow. Up to that time the Corporation had no more thought of going into the street-railway business than of obtaining a water supply from Mars. But when two companies competed for the monopoly the municipal authorities wakened up to oppose the granting of exclusive rights to either. Then the two syndicates coalesced as the British and Foreign Tramway Company, but this Company was only allowed to proceed with its Bill by inserting a clause which gave the Corporation the option of taking over the whole measure within six months after enactment.

So far the Corporation had been backward. Where they exhibited foresight was in securing the option not only to construct the lines instead of the Company, but also either to lease or to operate them. Before the six months were up the Town Council decided to build the track and lease it. The British and Foreign Tramway Company, Ltd., by the Act, acquired as promoters the first right to a lease. This right was assigned to a new company called the Glasgow Tramway and Omnibus Company, Ltd., to whom, for the sum of £350,000, the original Company handed over the lease (valued at £179,576), and supplied horses, cars, etc. (valued in the final summing-up at £116,424), to start the business. In effect, then, the London promoters made £180,000 out of this little deal, and the Glasgow Tramway and Omnibus Company started life with that debit and nothing to show for it. Nevertheless, although this big amount had to be written off out of profits, besides the heavy annual charges of the Corporation for interest, wayleave, rental, and sinking fund, the Glasgow Tramway and

Omnibus Company were, after the first few years, when they were learning their business, uniformly successful and paid good dividends to the end.

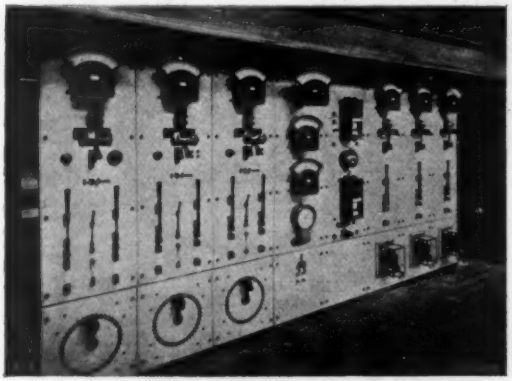
The lease to this Company was for a term of 23 years from and after the 1st July, 1871. The expenditure by the Corporation on the original track, and on extensions during the currency of the lease, was £345,000. Towards this the Company paid annually into a sinking fund, which at the termination of the lease amounted, with interest, to £201,500. Therefore, when the Corporation assumed possession of the track, they did so practically at a cost of £143,500. Contrast this with the £180,000 paid away by the Company as promotion money before even they could run a car. During the 23 years of the lease the Company paid to the Corporation £240,239 for interest on capital expenditure, and £45,992 as mileage rate. The Corporation expenditure during the same period, for interest on the money borrowed to build the tramway track and on sinking fund, was £222,604, so there was a clear profit of £63,628 made by the Corporation out of the Company, besides the reduction in capital account by £201,500 as above stated.

The lease was terminable in 1894, but by special agreement negotiations for the renewal of it were to begin five years before the date of expiry, and these negotiations might extend over six months. Thus in 1889 began the discussion of conditions of renewal. There had been some public dissatisfaction with the working arrangements of the Company, and there was no doubt as to certain reforms being desired by the citizens. But the Corporation went a good deal further than any expression of public opinion, and laid down very stringent conditions. Thus, they required that the working week of tramway servants should not exceed 60



THE ENGINE ROOM: SPRINGBURN POWER STATION.

hours; that no advertisements should appear on either the outside or the inside of the cars; that the drivers and conductors should wear uniforms; that the services of cars should be more frequent; and a number of other major and minor details. Moreover, they offered to renew the lease for five years only, retaining the right to obtain access to the lines two years before the expiry of the lease in order to prepare the track for mechanical haulage. The Company declined these conditions, and instead of inviting offers from others, or putting the lease up to public competition, the Corporation decided to take over the working when the lease expired in 1894. This they had the power to do, owing to the wording of a clause of the Act of 1870 as already mentioned, which considerably simplified the situation.



SWITCHBOARD AT SPRINGBURN STATION.

Soon after this decision was come to, negotiations were opened with the Company with a view to taking over their horses, rolling stock, plant, and premises, when the time came, at a fair valuation. The Corporation could afford to pay a better price, as a going concern, than the Company could get otherwise, and there was obvious advantage to both parties in coming to terms. But while negotiations were proceeding, the Company began to make preparations to organise a complete system of omnibus traffic in opposition to the tramways, as soon as the lease expired. Thereupon the Corporation intimated that a condition of their purchase of the Company's property would be that the Company should not enter into competition for the street traffic. The Company indignantly repudiated the right of the Corporation to make such a condition. Tempers rose, letters flew round, the backs of everybody got up, and finally the Corporation told the Company they would not buy their property at any price, and the Company told the Corporation to go where the woodbine twineth—or words to that effect. And so it came to pass that the Corporation had to buy ground and build entirely new stabling and car sheds, to buy 3,000 new and unbroken horses, and to build some 300 cars—all within a couple of years; whilst the Company had to sell their old cars practically for match-wood, and to roup off their horses in batches for what they could get. That is to say, there was a fearful and foolish waste of money on both sides, and the Corporation began the municipal enterprise with a much greater initial expenditure on equipment than there was any real necessity for.

On the morning of Sunday, the 1st July, 1894, the Corporation service began. By that time stabling had been erected for 3,500 horses, car sheds for over 300 vehicles, and nine separate sets of premises had been constructed in the most suitable localities, including granaries, repair shops, etc. The completion of the stables only left three months in which to bring in 3,000 horses from America and the Continent, and to try them in harness and on street work. But it was done, and starting prudently with a half-service of cars until the horses got hardened and trained, within three months the Tramway Department of the Corporation doubled the service that the Company had afforded. At the same

time they reduced the fares by lengthening the penny stages, and by introducing half-penny fares for half-mile stages. It may be, perhaps, that they would not have been so ready to do this had the displaced—and displeased—Company not put some 175 three-horsed buses on the streets to run against the cars. This competition went on for some months before the Company found—or owned—that the game was not worth the candle. As a not inappropriate way of burying their hopes of beating the Corporation, the Company went into the "undertaker" business.

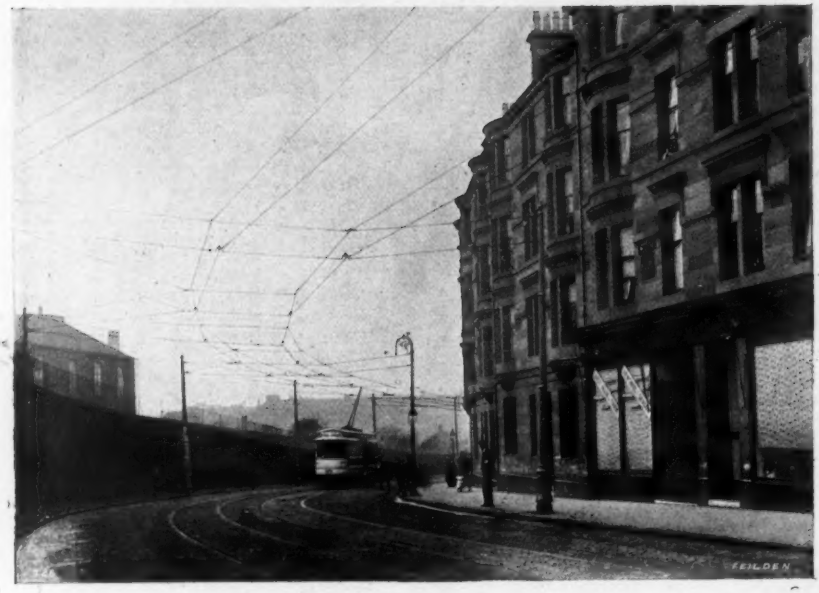
And now a word as to finance before we examine the mechanical aspects of the Glasgow system. At the end of the first eleven months, which brought the enterprise down to the end of the Municipal financial year, there was a surplus on working of £24,204. This, however, was not commercial profit, for out of it had to be allocated the payment to the Common Good (or Capital Account of the City), then rated at £9,000 per annum, equivalent to street rental, and provision for depreciation and for renewal of the permanent way. Still, there was an actual surplus of traffic receipts over working expenditure. Each year since has shown progressive results.

The following is an abstract of the last balance-sheet issued, that for the year ending 31st May, 1899:—

| | | | |
|---|---|---|---|
| Traffic Receipts— | | | |
| From Horse Traction ... ... | £410,124 4 10 | | |
| ,, Electric Traction ... ... | 23,003 15 8 | | |
| | | £433,128 | 0 6 |
| Other Receipts ... ... ... ... | ... ... ... | 6,096 | 1 2 |
| Total Receipts ... ... ... ... | ... ... ... | £439,224 | 1 8 |
| Working Expenses— | | | |
| Horse Traction ... ... ... | £307,542 4 2 | | |
| Electric Traction ... ... ... | 10,563 13 11 | | |
| | | £318,105 | 18 1 |
| To net Revenue Account ... ... | ... ... ... | £121,118 | 3 7 |
| Whereof applied— | | | |
| Rent of Govan Tramway ... ... | £ 4,908 15 5 | | |
| Interest on Capital ... ... ... | 12,926 12 8 | | |
| Sinking Fund ... ... ... | 11,352 10 8 | | |
| Common Good (rent) ... ... | 9,000 0 0 | | |
| Depreciation off Capital ... .. | 29,157 13 10 | | |
| | | £67,345 | 12 7 |
| Transferred to General Reserve Fund ... | ... ... ... | £53,772 | 11 0 |

This Balance is sometimes spoken of as the "profit" of the tramway system. It is a substantial surplus, but it would not be all available for dividends had it been gained by a company, because there are various contingencies to provide for. Thus, the horses stand in the books at an average of £22 each, which it is tolerably certain they will not bring, especially if the bulk of the stud of 4330 has to be sold two or three years hence, as the new electric equipment (presently to be described) is completed. Again, 384 horse-cars stand in the books at an average of about £150 each. Yet the major portion of these will be utterly useless two or three years hence, since they cannot be adapted to electric traction. Some of the best cars can be converted at a cost of about £50 each, that is to say, can be altered at that cost so as to receive the electrical equipment which, of course, will be extra; but it has, we believe, been decided that it will be more economical in the long run to build new electrical cars than to convert the old ones. There is no market for them otherwise. A joint-stock company would have had to provide for this prospective loss by writing off depreciation out of profits much more liberally than the Corporation have done.

It is not our purpose just now to discuss the principle and practice of municipal trading, and we merely point out in passing that all the balance shown



SPRINGBURN ROAD, SHOWING CURVE

in the accounts of the Glasgow Tramway Department is not commercial profit. On the other hand, an energetically managed company would have, ere this, displayed a larger surplus on such a magnificent property, as there are in it sources of profit which the Corporation neglect, and the working expenses are greater than a company working for profit would permit.

The following shows the progressive character of the traffic and the returns since the Corporation took the management :—

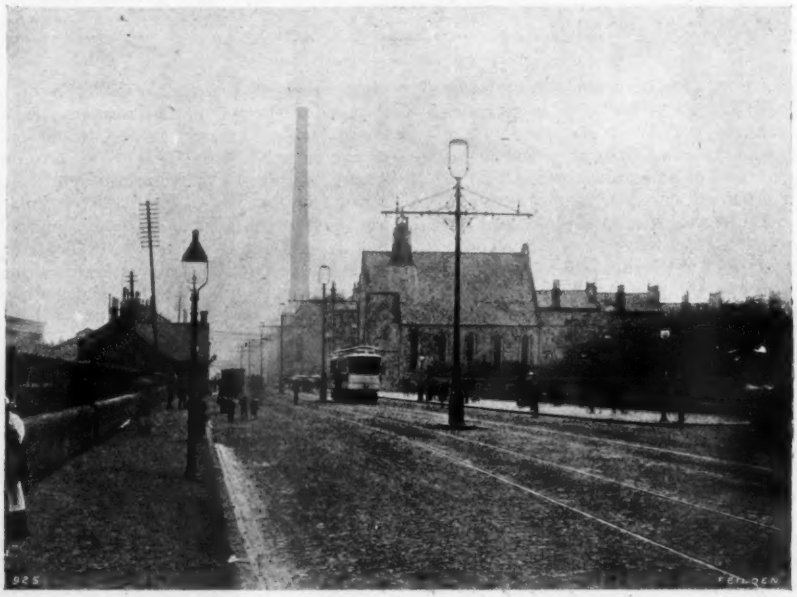
| Year. | Average cars. | Mileage. | Passengers carried. | Receipts. | Average per mile. |
|---|---|---|---|---|---|
| | | | | £ | d. |
| 1895 (11 months) | 171 | 5,192,031 | 57,104,647 | 222,121 | 10·26 |
| 1896 | 227½ | 6,932,650 | 86,462,594 | 328,827 | 11·38 |
| 1897 | 268¼ | 8,127,111 | 98,966,658 | 365,761 | 10·80 |
| 1898 | 281 | 8,483,012 | 106,344,437 | 389,216 | 11·01 |
| 1899 | 306 | 9,071,640 | 118,775,668 | 433,128 | 11·46 |

The total cost of provender and litter in the last financial year was (less sales of stable manure) £81,753, or equal to 7*s.* 3·23*d.* per horse per week. The average number of horses in the year was 4,313. There were 384 horse-cars and 35 electric cars, besides a number of omnibuses and other vehicles, which cost for maintenance and renewals £10,187. The Corporation have now workshops in which are built and repaired most of the cars, but the first equipment

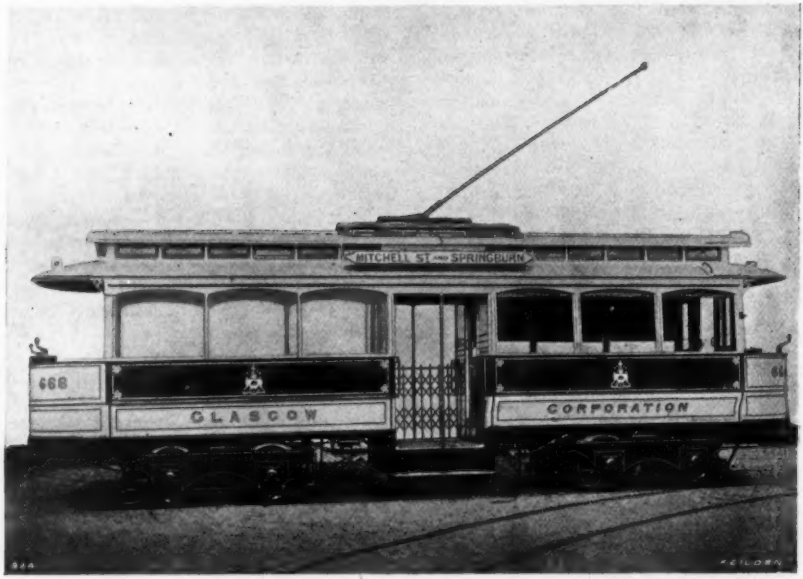
was bought from English builders, and occasionally orders are still given out; most of the new electric cars are being provided by outside builders. The cost of renewals and repairs of the permanent way last year was £10,522, which was paid out of revenue. During the year some three miles of track were renewed for electric traction, about which we shall speak presently. The total capital expenditure up to 31st May last was £758,760, from which, since 1894, £92,284 has been written off for depreciation, leaving the net capital at £666,476, of which £492,368 has been borrowed.

The first tramway car was run in Glasgow, by the leasing company, on 19th July, 1872, and the first section open for traffic was one of 2½ miles from St. George's Cross by way of New City Road, Sauchiehall Street, Renfield Street, and across Jamaica Street Bridge to Eglinton Toll, on the south side of the river. By the end of that year nine miles were open for traffic, and when the lease came to an end there were 31½ miles open. This, then, was the extent of the system which the Corporation undertook to work by horse haulage, until it could be decided what mechanical motor should be adopted. Other 3½ miles, which were in course of construction, were opened for traffic within a year or so after the Corporation took the reins. More additions have been made since, and the system now covers 36 miles of double track, in addition to which the Corporation of Glasgow lease and work four miles in and owned by the contiguous Burgh of Govan.

The lines are so planned as to radiate in every direction from a busy centre about midway between the central railway stations of the three great railway companies,—Caledonian, North British and Glasgow and South-Western. All the cars running east and west, north and south, pass through this centre, from some portion of which, within a small radius,



SPRINGBURN ROAD, SHOWING CENTRE-POLE ARRANGEMENT.




SINGLE-DECK DOUBLE-TRUCK CAR.

the traveller can get at almost any minute to every quarter of the city and far into the suburbs. The system of long through-routes has been adopted as permitting of a quicker and more regular service than can be maintained where stoppages have to be made and the course reversed in busy thoroughfares. Glasgow is particularly well adapted to the long-route system, for on every one of the through main routes the intermediate traffic is continuous and enormous. It was to encourage this intermediate traffic that the halfpenny half-mile stages were instituted, while to encourage long-distance travelling three successive half-mile stages are allowed for a penny.

It is to be remembered that not only has Glasgow, with its suburbs, a population of some 800,000 to serve—the majority, perhaps, of whom live at some distance from their work or business—but it is the centre of a great industrial district and has three-fourths of the population of Scotland within an hour's railway journey of its busy streets. It has, therefore, besides its resident population an immense daily floating population, augmented during four or five months of the year by a constant stream of tourists "passing through." In short, Glasgow has a comparatively small tramway track for a very large migrant population. It is, therefore, so peculiarly well adapted to tramway enterprise that nothing but the grossest mismanagement by Company or Corporation could have prevented the tramways from being remunerative.

Having shown how the Glasgow tramway system originated, and how it has developed under municipal management, we have now to describe the revolutionising of the system from animal to mechanical traction.

From the moment when municipalisation was resolved on the adoption of mechanical motors was also determined. The necessary powers were obtained in 1891, and in that year a special committee was appointed to inquire into the various

systems of mechanical traction in use in Britain and other countries, and to report as to the system most suitable for Glasgow. It was soon seen, however, that no decision could be come to on this subject before the termination of the Company's lease, and that, therefore, the Corporation would have to begin business with horse-haulage. This has been both a disadvantage and an advantage. It has given more time for consideration, but it has also necessitated a larger capital expenditure as well as a somewhat fruitless expenditure on investigation. The Corporation were certainly in no hurry to arrive at a decision, for it was not until the middle of 1896 that the Committee reported "That the overhead system of electric traction is the simplest, cheapest to construct and work, more accessible for maintenance and repairs, and on the whole the most efficient system of mechanical traction which has yet been demonstrated by practical working."

The cable system had been carefully considered and found wanting, because of the configuration of the city, and also because in the principal thoroughfare, Argyle Street, the surface of the street is within a foot of the iron-girdered roof of the tunnel of the underground railway of the Caledonian Railway Company. This was, perhaps, not an insuperable engineering difficulty, but the streets are on too rectangular a plan for effective and economical cabling. The controversy really lay between the conduit and the overhead trolley system of electric traction, and it went on for about two years before the Town Council finally approved the recommendation of the Tramways Committee—to equip experimentally one line of route from Mitchell Street, in the heart of the City, to Springburn, in the northern suburbs, a clear run of about 2½ miles. It was also decided to utilise the traction poles on this route for electric lighting purposes, only the lighting power in this

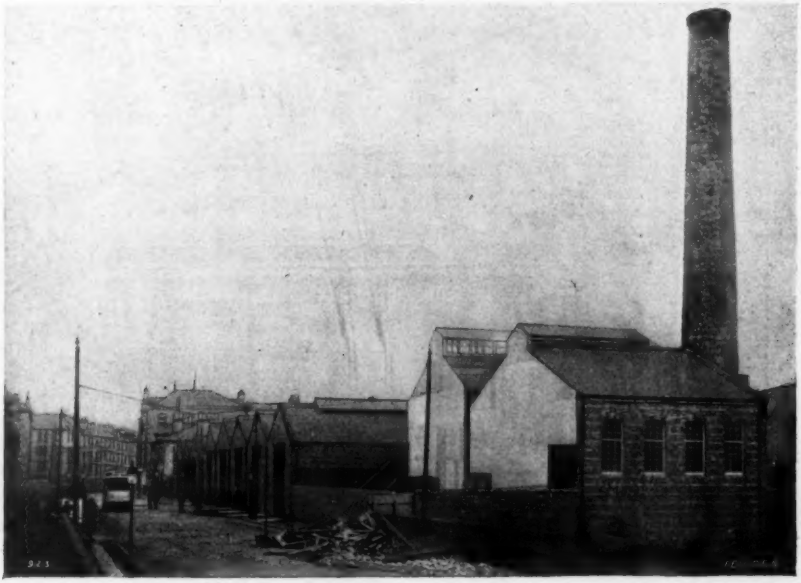
DOUBLE-DECK SINGLE-TRUCK CAR.

case is supplied by another department which has charge of the entire lighting of the City.

The Tramway Department decided to erect a power-station at the Springburn end of the route, and after advertising for tenders, accepted the offer of the Westinghouse Electric Company for the supply of the electrical equipment. This was in November, 1897, and the line was opened for traffic on October 15th, 1898. In January, 1899, an extension in connection with the Springburn line was opened from Parliamentary Road to the east end of Argyle Street (Glasgow Cross). Later, this line was extended from Glasgow Cross, down the Saltmarket, and across the river to Govanhill on the south side.

The advantage of the Springburn route for experiment consists in the fact that it is separate from all the other routes, for while crossing several tracks no other cars run over any portion of this particular track. From terminus to terminus the length is $2\frac{3}{5}$ miles of double track, beginning at Mitchell Street on the level, rising to a gradient of 1 in 19, followed by a gentle ascent of 1 in 50, then a fairly level run finished by a sharp ascent at the finish—the total rise being about 193 ft. with an average of 1 in $61\frac{1}{2}$ ft. Through its whole length the route traverses a populous and busy district.

In the northern portion it so widens up that centre poles have been adopted. On the rest of the route span wires are used, which, on the greater portion of the route, are suspended from steel posts on both sides of the street, every 120 ft. Every alternate post is utilised by the Lighting Department for hanging an electric lamp. The poles are 31 ft. high and are embedded in $6\frac{1}{2}$ ft. of concrete. In West Nile Street, however, there are no poles, and the span wires are fastened to the buildings on each side by means of rosettes. The trolley wire is double throughout; and is of No. 00 Brown and Sharpe gauge, with a conductivity of 98 per cent., and a breaking strain of



COPLAWHILL DEPÔT.

COPLAWHILL WORKS: EXTERIOR.

6,000 lbs. It is supported on and soldered to ears 18 in. in length. The overhead wire is more flexible than the suspension wire. It is always over the centre of the track, and the trolley is fixed on the centre of the car without any swivel. Throughout the route, guard wires are placed 24 in. above the trolley and span wires.

The power station is within half-a-mile of the Springburn terminus, and is built of brick. It was planned with a view to future extension, which, however, will not now be needed, as we shall presently see. The boiler room is 46 ft. by 33 ft., and contains two Babcock and Wilcox water-tube boilers, fitted with Vicar's automatic stokers. Each boiler has a capacity of 250 h.-p. with a heating surface of 2,530 square ft., and a grate area of 51 square ft.

The engine room is 61 ft. by 36 ft. and is 34 ft. in height. The three engines are McIntosh & Seymour's compound tandems with a 24-in. stroke, cylinders 11 in. and 22 in. diameter, a speed of 200 revolutions per minute and an efficiency of 90 per cent. The foundations extend down to the floor of the basement in which the steam-pipes are placed. The steam and feed pipes are all in duplicate, and the exhaust piping is arranged for the engines working non-condensing or condensing through a Worthington condenser and cooling tower. Compound engines drive the air and circulating pumps, and a "Brotherhood" three-cylinder engine drives the fan for the cooling tower. Each engine is coupled to a 200-kilowatt generator (300 amperes at 550 volts), and each generator is of the Westinghouse standard type with eight poles and drum-wound armatures. Their efficiency is 94 per cent., and the combined efficiency of engine and generator is 85 per cent. They stood the test of a continuous run for

twenty-four hours at full load, and then for half an hour at 50 per cent. overload. The switchboard adjoins the car-shed, and is of white marble in seven panels, one for each machine, one for each of the cables, and one for carrying the Board of Trade instruments. The measuring instruments have illuminated dials and can be read from any point of the engine-room.

The permanent way on the Springburn route had been down for twelve years, and was much worn by the heavy cart traffic. It was decided, therefore, to relay the whole track with 100 lb. rails to a 4 ft. $7\frac{3}{4}$ in. gauge. The rails are laid on a 6-in. bed of Portland cement, which extends 18 in. beyond the outside rails. The rails are in 45-ft. lengths and the dimensions are, depth $6\frac{3}{4}$ in.; width of head on roll $1\frac{7}{8}$ in.; over all $3\frac{1}{4}$ in.; width of groove $1\frac{1}{4}$ in.; width of sole $6\frac{1}{2}$ in. They are secured by steel fish-plates weighing 48 lbs. per pair and measuring 24 in. in length, fastened by six 1-in. bolts. They are tied to gauge at intervals of 7 ft. 6 in. by steel tie-bars 2 in. by $\frac{3}{8}$ in., which tie-bars are at one end notched in the usual manner, and at the other end by two $\frac{7}{8}$ in. nuts. Drain rails are used where necessary. The street is paved in its whole width with granite setts, grouted with bitumen and granite chips. Next the rail cast-iron paving blocks are laid on each side between each granite sett in order to lessen the wear and tear of the paving. Whilst the track was being relaid the ducts for the feeder and other cables were laid in a trench under the four-foot way.

The car-sheds had been originally built for the horse-cars, and along with the stables have been adapted for the electric cars. There are eight of them, 90 ft. in length, and 27 ft. in width, and with 15 tracks and a total length of 415 yds., ten of which tracks have inspecting and repairing pits. Service on this route began with 21 single-deck cars on two bogie trucks, and two double-deck cars on single trucks, designed by the General Manager, Mr. John Young, and built at the Corporation car-works at Coplawhill. The single-deck cars are of somewhat unique pattern, having the entrance and exit in the centre, with fore and aft compartments seated for 50 passengers in all. The centre doorway, however, has been found inconvenient in practice, and is not being adopted on the extension routes.

This, then, was the beginning of electric traction on the Glasgow tramway system —a small beginning, which we have described in some detail, because it was destined to have great results. Meanwhile, the traffic is so steadily increasing that no sooner were 150 horses displaced from the Springburn route, when the electric cars started there, than they were absorbed on other routes.

At the end of the financial year 31st May, 1899, there were $3\frac{1}{4}$ miles double track of electric tramways in operation, from which was derived a revenue of £23,039 against a working expenditure of £10,563. The net results of both horse and electrical traction are shown in the following abstract in which, however, 12 months of animal haulage compares with only eight months of electricity:—

ABSTRACT OF WORKING.

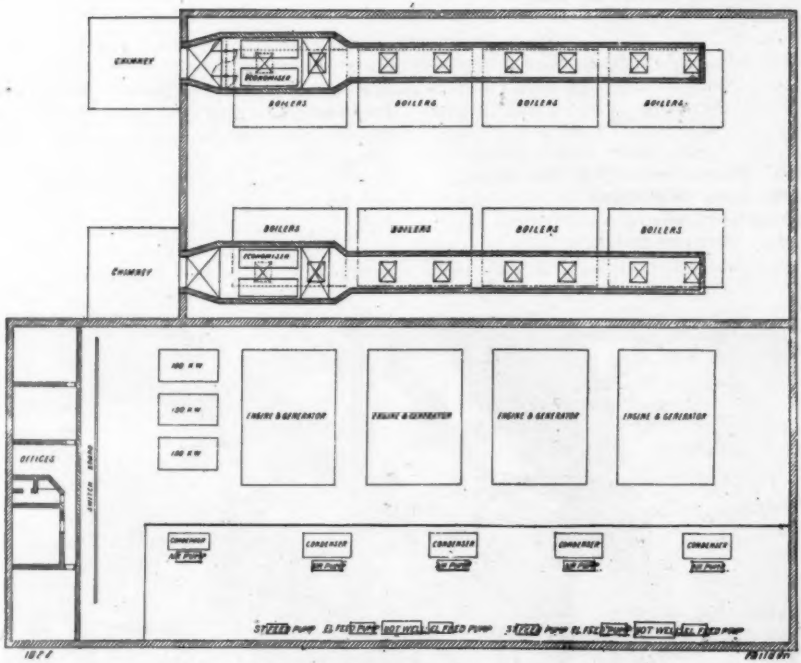
| | Aver. Cars 16 hours day. | Mileage. | Receipts. | Average per mile. |
|---|---|---|---|---|
| Horse Traction ... ... | 287·28 | 8,674,170 | £410,124 | 11·34 |
| Electric Traction (545·830 K. W. power) | 18·57 | 397,470 | 23,003 | 13·89 |
| Total ... ... | 305·85 | 9,071,640 | £433,127 | 12·61 |

SOME PERCENTAGE RESULTS.

| | Horse Traction. Per cent. | Electric Traction. Per cent. | Total. Per cent. |
|---|---|---|---|
| Working Expenses to gross receipts ... | 7·89 | 45·85 | 72·42 |
| Traffic Revenue per car-mile ... ... | 11·34 | 13·89 | 11·46 |
| Average Expenses per car-mile ... ... | 8·51 | 6·38 | 8·41 |
| Average Fare per passenger ... ... | ·874d. | ·892d. | ·875d. |

CAR WORKSHOP AT COPLAWHILL.

A trial balance at the end of December, 1898, was so satisfactory as showing the saving by electric traction on the Springburn route, that on 5th January, 1899, the Town Council resolved that immediate arrangements should be made for converting the whole Corporation system. The immediate object in view was to have as much as possible of the system converted before the Glasgow International Exhibition of 1901 is opened. The conversion of the track was at once begun and is proceeding in sections, and arrangements were made for extending the accommodation at the depôts and workshops. The question of power, however, was not settled until 16th March, 1899, when on a vote the Town Council decided, by a majority, that the Tramway Department should generate power for the whole tramway system, apart altogether from the Electric Lighting Department. There are thus, now, two electric power-generating departments in the Corporation. Mr.

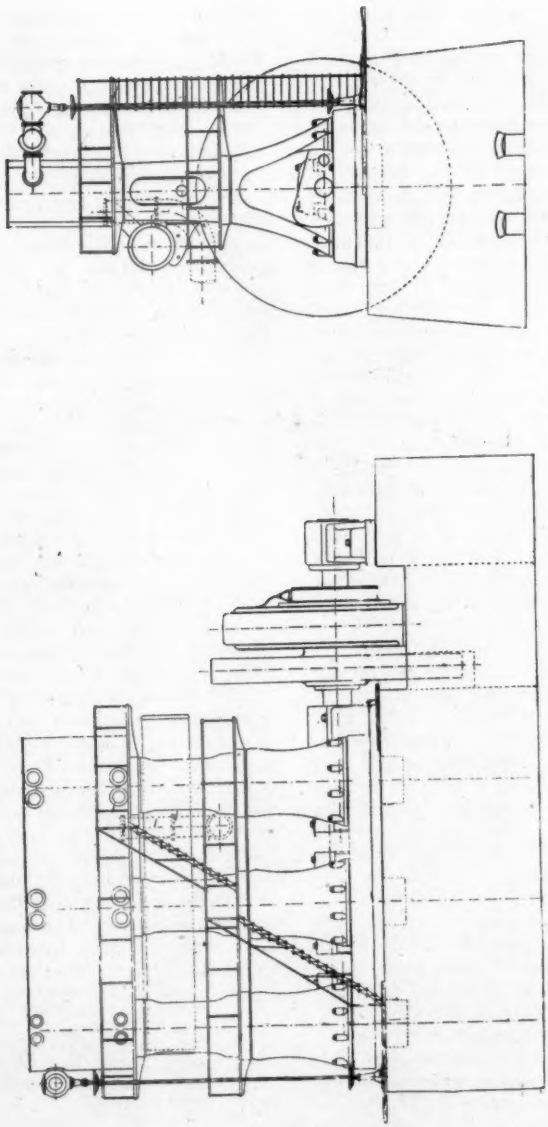



PLAN OF HIGH-TENSION GENERATING STATION, GLASGOW TRAMWAYS.

H. F. Parshall, C.E., was employed to report on the whole subject of generating and distributing the current, and was afterwards engaged as permanent consulting engineer for the Tramway Department.

The general scheme is to have for the whole system one high-tension generating station, with five sub-stations. For the main generating station, a plot of ground 18,800 square yards in extent was acquired at Port Dundas, in immediate connection both with the Forth and Clyde Canal, and with the two main railways, North British and Caledonian. The work of converting the track was blocked out in seven sections, of which the first two are nearing completion, the third will be completed in 1900, and the contracts for the remainder are being allotted. The main object in view in arranging the first routes to be converted was to bring the outlying parts of the City into direct connection with the site of the Exhibition before the spring of 1901.

The method of traction adopted is the overhead trolley, as on the experimental Springburn line. The trolley is not sightly, and does not add to the amenities of the City, but on the other hand the experience of the Springburn line is that the wire is not by any means so unsightly as was feared. And the same reason which prevented the adoption of cable haulage in the main business thoroughfare (Argyle Street), also put the electric conduit system, as at present constituted, out of court. Practically, the people of Glasgow had only a Hobson's choice before them when they resolved to have mechanical motive power. They were, however, a long time in making up their minds, largely because of the reputed unsightliness of the overhead system, and it is not at all improbable that as soon as that system is thoroughly installed—if not



ARRANGEMENT OF VERTICAL COMPOUND ENGINE AS CONSTRUCTED FOR THE GLASGOW TRAMWAYS.

sooner—they will begin to cast about for something better.

When conversion was decided on there were 380 horse cars and 27 electric cars in operation. But with a view to extensions, and to the development of traffic expected under electric traction, a basis of 600 cars was adopted by Mr. Parshall in planning the generating and distributing plant. He justified the provision of such a wide margin for increase on the plea, *inter alia*, that in Boston, U.S., with a smaller population and not a larger area than Glasgow, double that number of cars are operated at a profit. A stronger point, perhaps, is that experience has proved that when traffic outgrows the capacity of the electric plant installed, the cost of providing the additional power is always greatly beyond the original cost.

The track of the Glasgow system is remarkably well adapted for electric traction, but the system of low fares and short stages necessitates frequent stops which make the amount of power to be provided greater than that consumed in many other cities. On the Springburn line the average consumption of power at the car is 7·2 kilowatts, or 9·65 h.-p., and this figure has been considered a fair one to take for the whole system. For 600 cars this would mean an average delivery of 5,800 h.-p. But the ratio of the average to the maximum varies according to the hour of the day, the weather, etc., and to provide for the maximum load it is necessary that 60 per cent. should be added to the average. That is to say, the machinery must be capable of delivering 9,250 h.-p. to the cars, which, allowing for loss in transmission and generation, means that at least 11,500 electrical h.-p. must be generated. In order to allow a safe margin for spare plant, however, an aggregate of 17,000 i. h.-p. in the generating station is being provided for.

As the distances to which energy has to be conveyed in Glasgow are too great and varied to permit of an economical supply at 500 volts, several centres of distribution are arranged. There is additional reason for this in the Corporation's property in gas and water-pipes, which would entail, in the case of a single centre of distribution, an elaborate complicated and costly return system. It was calculated by Mr. Parshall that the amount of current which would be returned through the rails in Glasgow to a central point would be sufficient to eat away 50 tons of iron per annum from the pipes. Five centres of distribution will suffice for the existing and contemplated arrangement of car routes.

An important point to settle was whether the energy required can be supplied more economically from a single generating station, by generating polyphase currents at high voltage to be transformed at the sub-stations into continuous currents at 500 volts, or by a number of stations generating as well as distributing continuous currents at 500 volts. The advantages of one high-tension generating station with sub-stations, over several low-tension generating stations, are (1) a smaller initial capital expenditure on ground, building and plant (especially in Glasgow, where the car-sheds and stables are suitably located for sub-stations, though not for generating stations); (2) smaller expenditure in working costs, maintenance and repairs, as also in fuel and water; (3) greater flexibility and better adaptability to the requirements of future extensions; (4) a great saving of time in effecting the installation, a matter of great importance in converting a large system from horse to electric traction. Other advantages might be named, but without elaborating the point, we reproduce for the benefit of those interested in such matters the following comparison of the computed cost of construction of the two systems:—

(1) Cost of construction of a three-phase generating station containing four 2,500 K.W. units, including building and plant, together with plant for sub-stations, &c:—

| | |
|---|---|
| (a) Generating station building, steel work, and brick-work, foundations for engines, &c. ... ... | £45,000 |
| (b) Equipment, including steam units, boilers, coal conveyor, condensers, pumps, and electrical plant, &c. ... ... | 180,000 |
| (c) Sub-stations equipment, with rotary converters (5), transformers, switchboards, &c. ... | 70,000 |
| (d) Three-core high-tension cables for transmission at 6,500 volts... | 21,000 |
| Total ... ... ... | £316,000 |

(2) Cost of construction of five generating stations of approximately 2,000 K.W. capacity, each consisting of 500 K.W. railway units :—

| | |
|---|---|
| (a) Buildings, including foundations for engines, excavations and steel work, &c. ... ... | £150,000 |
| (b) Generating station equipment, including steam units, boilers, conveyors, condensers, pumps, electrical plant and auxiliaries, &c. | 240,000 |
| Total ... ... ... | £390,000 |

These are Mr. H. F. Parshall's figures, but they do not include the cost of ground and railway connections, which would obviously be greater for five stations than for one.

It is of interest to follow the comparison into practical working, for that, after all, affords the real test of the merits of the two methods of providing power on an extended system. The following, then, is an estimate in pence per K.W. hour of the cost of delivering to cars, on the basis of 600 cars running 16 hours per day, and 200 of them running from four to five hours additional per day, at an average of 7·2 K.W. per car :—

(1) Under a three-phase generating station containing four 2,500 K.W. units, with transmission at 6,500 volts, and five sub-stations containing 500 K.W. and 800 K.W. units :—

| Power Expenses. | Generating station. | Sub-station. | Generating and sub-stations. |
|---|---|---|---|
| | *d.* | *d.* | *d.* |
| Coal delivered & handled | 0·1240 | — | 0·1240 |
| Water at 4*d.* per 1,000 gals. | 0·0082 | — | 0·0082 |
| Oil, waste, &c. | 0·0088 | 0·0053 | 0·0141 |
| Labour | 0·0500 | 0·0360 | 0·0860 |
| | 0·1910 | 0·0413 | 0·2323 |
| Maintenance | 0·0257 | 0·0028 | 0·0285 |
| Fixed charges, viz. :—depreciation, interest, insurance, rates and taxes, &c. | 0·2081 | 0·0616 | 0·2697 |
| Total | 0·4248 | 0·1057 | 0·5305 |
| Add cost of maintenance, &c., of connecting high-tension cables ... | — | — | 0·0190 |
| Total cost | 0·4248 | 0·1057 | 0·5495 |

(2) Under five generating stations containing 500 volt railway generating plant :—

| Power Expenses :— | *d.* |
|---|---|
| Coal delivered and handled ... | 0·1550 |
| Water at 4*d.* per 1000 gals. ... | 0·0103 |
| Oil, waste, &c. ... ... ... | 0·0110 |
| Labour ... ... ... ... | 0·2000 |
| | 0·3763 |
| Maintenance ... ... ... | 0·0350 |
| Fixed charges (as above) ... | 0·3254 |
| Total ... ... ... | 0·7367 |

The difference between ·5495*d.* and ·7367*d.* on 600 cars amounts to £20,280 per annum saving in favour of the single polyphase station, in addition to the saving in capital expenditure.

It was upon these representations that Glasgow adopted the central high-tension generating station, with five distributing sub-stations, all of which are now in course of construction and equipment. At the generating station provision is being made for the generation of 26,000,000 Board of Trade units per annum, which is four times as much as the energy generated by the largest electric lighting company in London. The plant required, however, does not need to be more than one-third the nominal capacity required for a lighting station, because the machinery will be working at its fullest capacity for sixteen hours per day, and at one-third capacity for four or five hours additional. Four units of generation are provided—three to be working during normal conditions of load, and the fourth to provide for abnormal conditions and emergencies.

The main engines are of very massive construction, of the three-crank tandem compound type, connected direct to triphase generators of the fly-wheel type, with rotating magnets and stationary armatures. Two of these engines are being made by the E. P. Allis Company, of America, and two by Messrs. John Musgrave & Sons (Limited), Bolton. They are in many respects unique, and when finally erected in the generating station, will deserve fuller examination and description. That, however, will not be until next year.

We give a drawing of the E. P. Allis Company's engines. They will each be

capable of developing 4,000 i. h.-p. as their normal load and 5,000 as their maximum. Each will have three cylinders, 42″, 62″, and 62″, respectively, and the stroke will be 60″. The wheel will weigh 220,000 lbs., and the speed will not vary more than 1½ per cent. above and below the normal of 75 revolutions per minute, and the angular velocity per revolution will not vary more than one-fifth of one per cent. There are six bearings, one being the outboard. The shaft will be made in three pieces, and the following are the sizes of the journals: first and second, 22 × 36; third and fourth, 24 × 36; fifth, 32 × 64; and the outer, 30 × 48. Each engine will weigh about 780 tons. The first is to be erected and running by December 16th next, and the second a few months later.

The first two, if not three, sections of this most interesting application of electric traction by the overhead trolley on a large scale are to be in operation by May, 1901. This will involve some phenomenal activity in the turning out of a vast amount of complicated machinery, for great delay occurred in the placing of the contracts owing to the conflicting claims of British and American makers. The generation of power for the electric tramways is to be wholly under the Tramway Department, and apart altogether from the Lighting Department, which is busy completing a large power-station of its own. Up till now, Glasgow has been as far behind most other cities in electric lighting as it is ahead in other forms of municipal enterprise. No definite estimate has been made of the cost of converting the whole tramway system of Glasgow from horse-haulage to the method of electric-traction which is being adopted, but it will hardly be less than a million and a half sterling.

# Modern Appliances in Gas Manufacture.

By FLETCHER W. STEVENSON, M.I.C.E.

*(Continued from page 398.)*

## GASHOLDERS.

THOUGH gasholders do not strictly come under the heading of "appliances in gas manufacture," yet they play so important a part in the equipment of a gasworks that to omit a description of them would leave this article very incomplete. Moreover, there is no portion of the gasworks that offers such scope for engineering skill, and certainly in only one other branch of gas engineering has such a revolution in construction taken place in recent years.

The importance of gasholders to the gas manufacturer lies in the fact that he has in them a reserve of gas upon which he can draw during the few hours of maximum demand. And herein lies the assurance that an uninterrupted supply can be maintained, which the so-called opponent of gas—the electric light—does not possess.

A storage system for the latter has yet to be invented that will admit of the full energy being taken out of store that has been put in, and until this can be done the storage of electricity can never be

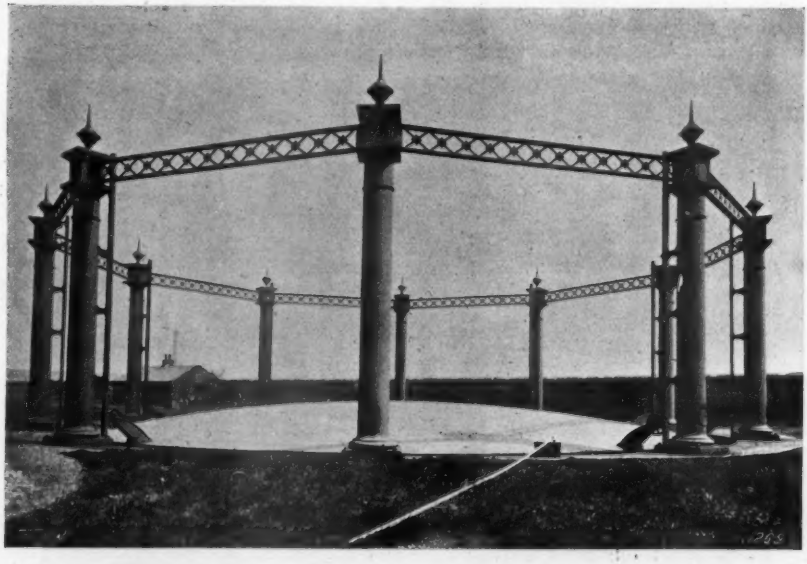


FIG. 68.—SINGLE-LIFT GASHOLDER AT THE DENTON GASWORKS, HAVING HEAVY CAST-IRON COLUMNS. SIZE, 90 FT. DIAMETER BY 24 FT. DEEP. THIS GASHOLDER HAS NOW BEEN CONVERTED BY ASHMORE, BENSON AND PEASE, INTO ONE OF TWO LIFTS, THE COLUMNS BEING REMOVED AND THE GUIDING EFFECTED BY THEIR PATENT ARRANGEMENT OF STEEL CABLES.

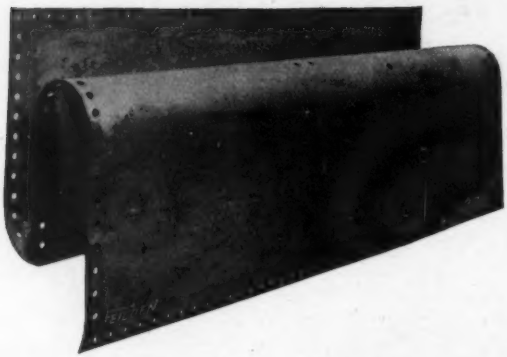


FIG. 69.—ONE LENGTH OF CUP AND DIP OF TELESCOPIC GASHOLDER READY FOR RIVETING UP TO ADJOINING LENGTHS.

economical, though to a certain extent it may be necessary. Unlike electricity, the storage of gas is simple and reliable, and every 1,000 cubic feet of gas put into store can be taken out when required.

It is usual to have storage equal to the maximum day's make of gas in mid-winter, and even a greater capacity is advocated by many engineers.

The gasholder in its simplest form, and as originally used, consists of a hollow cylinder closed at one end and inverted in a tank of water, the gas being brought into it by a pipe rising above the surface of the water inside. The pressure of the gas overcoming the weight of the cylinder raises the latter, and the weight of the cylinder maintains the pressure, so that as the gas is required it passes out through the stand-pipe inside and the cylinder descends.

To maintain the vertical position of the cylinder as it ascends and descends, columns are fixed around it having guide-bars attached to them, and pulleys are secured to the top and bottom of the cylinder and work in contact with these guides. The columns and guides, together with the bracing and ties to give them the necessary rigidity,

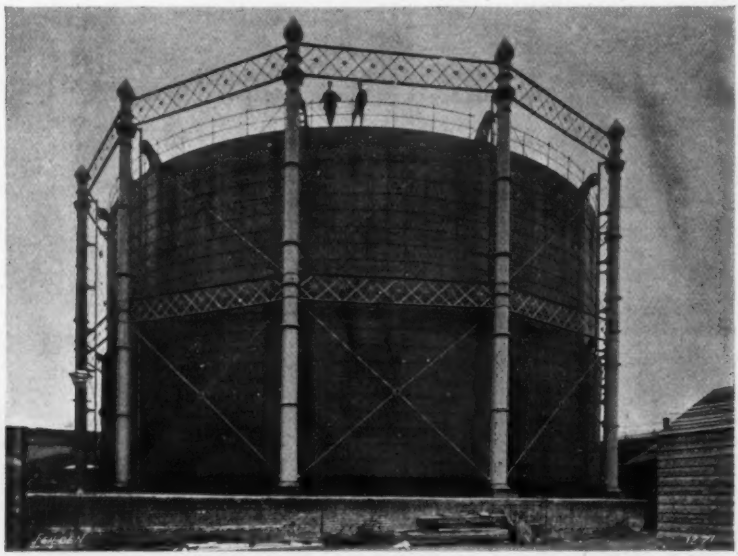


FIG. 70.—TWO-LIFT GASHOLDER AT THE CHESTER GASWORKS. SIZE, 90 FT. DIAMETER, EACH LIFT 24 FT. DEEP.

compose the guide framing, the cylinder being the bell or floating portion of the gasholder. (Fig. 68.)

The next step in gasholder construction was to make a telescopic gasholder, so that in the same tank of water the capacity was increased nearly 100 per cent. In this form the hollow cylinder is retained, but the lower edge is turned up on the outside all round to form a cup. This may, perhaps, be best likened to a man's tall hat, but with the brim turned up to U-shape, the brim forming the cup at bottom and the crown the top of the gasholder. Another cylinder, but open at both ends and rather larger than the first, is made outside the latter, and the top edge of this second one is turned down on the inside all round to such a size that it will fit into the cup at the bottom of the first cylinder (see Fig. 69).

The first or inner cylinder rising and becoming full of gas, the cup at the bottom (filled with water from the tank) grips into the inverted cup, or dip as it is called, on the outer cylinder, which it then raises, a liquid seal being thus made between the two preventing the escape of gas, and the now telescoped bell can rise to double the height of the single one.

In this form all telescopic gasholders are made, and the only alteration (except in details) effected since their introduction being in the number of cylinders or lifts used. The largest telescopic gasholder now in existence has six lifts.

The advantage of the multiple-lift gasholder is simply one of economy, the cost of the tank remaining the same for any number of lifts, while each one adds materially to the capacity of the gasholder, and, therefore, the proportionate cost is reduced.

The guide-framing originally was always made of cast-iron columns or standards, with suitable guides attached and tied together at the top with light girders. When the two-lift telescopic gasholder is used an additional girder is usually fixed between the columns at their centres to give additional rigidity.

Previous to the year 1881 there were only a very few examples of gasholders having more than two lifts, or that had

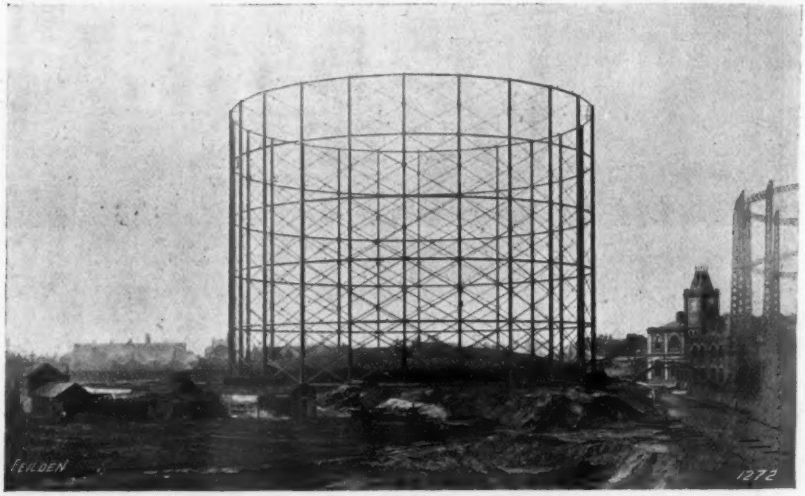



FIG. 71.—VIEW OF GUIDE-FRAMING OF TRIPLE-LIFT GASHOLDER AT THE OLD KENT ROAD GASWORKS. GASHOLDER IS 210 FT. DIAMETER, AND RISES, WHEN FULL, 160 FT. HIGH, AND CONTAINS 5½ MILLION CUBIC FT. OF GAS.

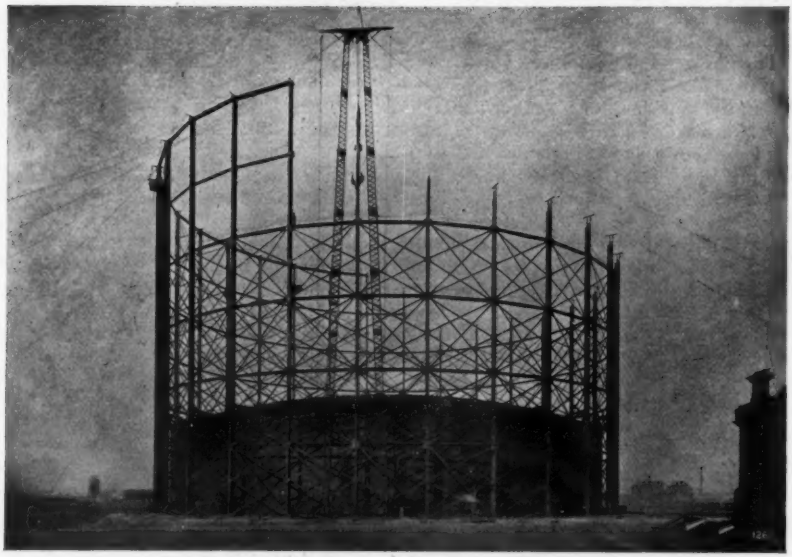


FIG. 72.—VIEW OF THE OLD KENT ROAD GASHOLDER, SHOWING GUIDE-FRAMING IN COURSE OF CONSTRUCTION, AND SHEAR-LEGS, 180 FT. HIGH, USED FOR ERECTING FRAMING.

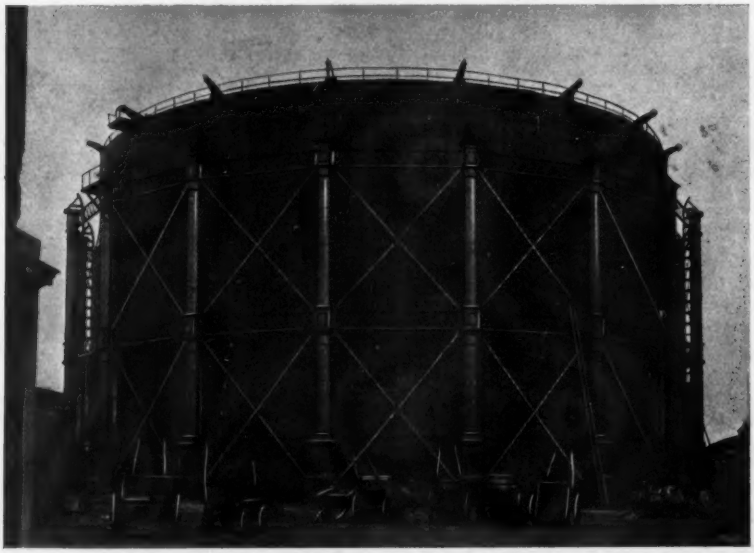


FIG. 73.—GASHOLDER AT THE ROTHERHITHE GASWORKS CONVERTED INTO A TRIPLE-LIFT ONE BY THE ADDITION, IN THE YEAR 1887, OF A FLYING LIFT.

standards for the guide-framing constructed of wrought-iron. But in that year Mr. George Livesey, then engineer of the South Metropolitan Gas Company, made an entirely new departure by constructing the largest triple-lift gasholder up to that time in use, and adopting a very light framing of wrought-iron standards, but so securely braced with light horizontal girders and flat iron wind-stays, as to make the guide-framing practically into a remarkably stiff cylinder, having a sufficient if carried up the height of one lift only, so that each of the first two lifts, as they picked up in turn the one below, would rise clear above the framing, and be securely held and maintained level by the lowest lift, which should remain in contact with the guide-framing.

In the year 1887, or nearly six years afterwards, Mr. Livesey applied in a modified form the suggestion he had made, by adding a third lift to a gasholder at Rotherhithe without raising the guide-

FIG. 74.—SIX-LIFT GASHOLDER AT THE EAST GREENWICH GASWORKS, HAVING TWO FLYING LIFTS. THIS GASHOLDER IS THE LARGEST IN THE WORLD, BEING 293 FT. DIAMETER, AND RISING, WHEN FULL, 180 FT. HIGH, CONTAINING 12 MILLION CUBIC FT. OF GAS.

circumference equal to that of the tank, to which, being bolted, it offered a greater resistance to overturning and distortion than anything that had previously been attained by the usual methods.

On the completion of this gasholder, and probably due to his observation of its working, Mr. Livesey made the startling suggestion that the guide-framing of such a gasholder might be reduced in height by two-thirds; that is, it would be framing; the new lift rising clear above it after the gasholder was two-thirds filled. (Fig. 73.) And again later, in the year 1892, he further applied it in the construction of the largest gasholder at present in existence, which has six lifts, the guide framing in this case being raised to the height of four lifts only, two being allowed to rise clear above it. (Fig. 74.) Numbers of gasholders upon this plan with one flying lift have since been erected.

While Mr. Livesey was adding the flying lift to the gasholder at Rotherhithe much discussion was taking place amongst engineers with regard to the question generally of guide-framing, and it was at this time that Mr. H. G. Webber suggested that it could be reduced to five or six feet high; in fact, only sufficiently high to insure that the lowest guide rollers on the bottom lift should be securely maintained in position, the lower stiffening ring on the bottom lift being greatly strengthened to prevent as far as possible its distortion under the greatest stress to which it would be subjected. This plan was condemned by almost every engineer, and there can be no doubt that as proposed by Mr. Webber the idea could not have been successfully applied. Yet it was a most fruitful suggestion, for within two years from the time it was made two inventions had been patented for dispensing entirely with the guide-framing, and both have been successfully applied and are now extensively adopted.

The first was the invention of Mr. Wm. Gadd, of Manchester, and consisted in replacing the usual vertical guides in the tank and inside the outer lifts by spiral guides, in contact with which worked double rollers gripping the guides above and below. (Fig. 75.) In this manner a spiral or corkscrew motion is given to the bell as it rises and falls, and the same tendency is imparted to it when subject to wind-pressure on sides or top. Tilting is impossible, because immediately the tendency occurs, the guides—set at an angle of 45° or 60°—prevent the bell rising or dipping vertically and impart a rotating tendency, and the whole bottom curb of the bell is then held as firmly as if bolted to the tank wall.

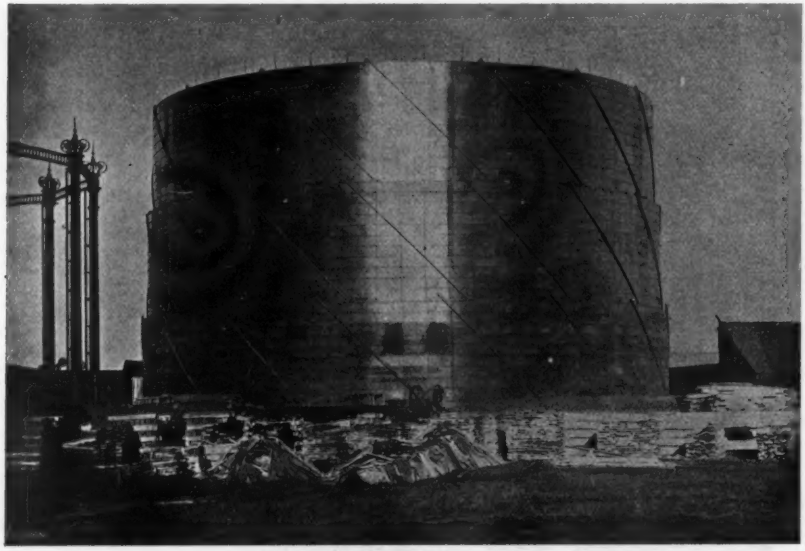


FIG. 75.—GADD'S PATENT SPIRAL-GUIDED TRIPLE-LIFT GASHOLDER AT THE WIDNES GASWORKS. SIZE, 114 FT. DIAMETER, AND EACH LIFT 24 FT. DEEP.

In the more recent examples the spiral guides are attached to the outside of the lifts and the rollers fixed to the tank wall and to the dips respectively.

It will be understood that with a gasholder guided as described, the stress on the bottom curb of the bell and the guide

FIG. 76.—PEASE'S PATENT CABLE-GUIDED TWO-LIFT GASHOLDER AT THE DENTON GASWORKS. THIS WAS ORIGINALLY A SINGLE-LIFT GASHOLDER, WITH HEAVY CAST-IRON COLUMNS, BUT WAS CONVERTED BY ASHMORE, BENSON AND PEASE, IN THE YEAR 1899.

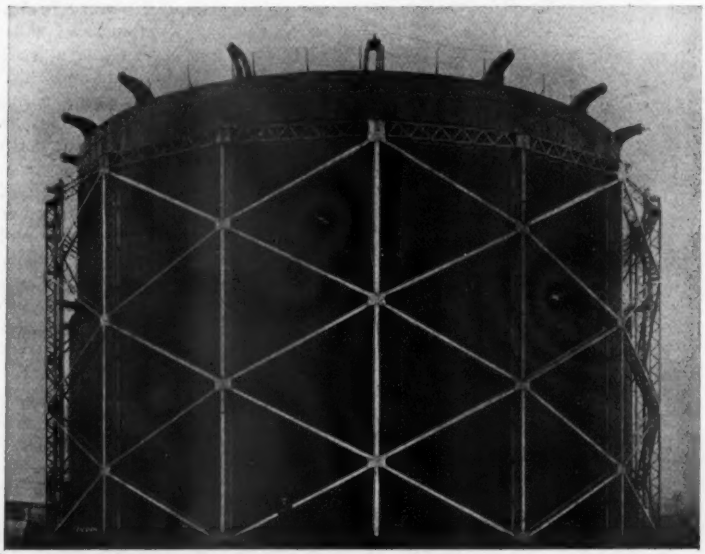


FIG. 77.—TRIPLE-LIFT GASHOLDER (82 FT. DIAMETER) AT THE ALDERSHOT GASWORKS, WITH CUTLER'S PATENT GUIDE-FRAMING RISING TO TOP OF SECOND LIFT. TOP LIFT RISES CLEAR OF GUIDE-FRAMING.

FIG. 78.—COWAN'S PATENT COMPENSATING STATION GOVERNOR.

rollers is very great when the bell is fully inflated and its whole leverage exerted; and a much greater stress is also thrown upon the thin sheets forming the skin of the bell. In these gasholders therefore, the bottom curb is made much stronger, and the sides of the bell are considerably strengthened with stiffeners.

The second invention referred to is that of Mr. Lloyd Pease, of the firm of Ashmore, Benson & Pease, in which cables or wire ropes are used to replace the external guide-framing (Fig. 76). At the first glance the system seems very complicated, but it is really extremely simple, and consists in substituting a cable for each column; the cables being worked in pairs and arranged to withstand pressure coming from opposite sides.

Taking the example of a single-lift gasholder, and considering the one pair of cables which replace two columns—one on each side at points opposite to each other—one cable is secured to the tank wall and is taken up and over the crown on pulleys, then down the opposite side, passing under a pulley fixed to the curb of the bell, up again, and terminating at a bracket fixed upon the tank wall. A force now acting upon the bell on the side from which the cable started would tend to tilt the bell from that side. To tilt, however, the bell must rise on the side from which the force acts and dip on the opposite side, and this the cable prevents, as the first side can only rise as sufficient cable is paid out by the other side rising. The second cable of the pair being now fixed in the reverse direction, neither side can rise or fall without the opposite side doing so to the same extent, and the bell is therefore kept perfectly level so long as the cables remain taut, and this is provided for by fixing a strong spring upon each one. The pairs of cables are fixed about 30 feet apart around the periphery of the bell.

In the case of telescopic gasholders the cables are similarly arranged in pairs, each cable being trained over pulleys on the respective lifts to guide them in turn in their ascent and descent.

The stress upon the bottom curb of the bell is not very greatly increased under this system of guiding as the stresses are chiefly in vertical directions. The thin sheets of the skin are, however, subjected to compression, but as there is a great surplus of tension stress due to the pressure of the gas within, this is unimportant.

Assuming that spiral and cable-guided gasholders are as safe as those having external guide-framing, it is hardly to be supposed that engineers would prefer to adopt the former except on the grounds

of economy in construction. That these methods are cheaper far than the old heavy guide-framings of former years cannot be disputed. But there can be no doubt that, first, by Mr. Livesey's example of the light stiff framing adopted in the large gasholder at the Old Kent Road, and second, by the better understanding of the duty the guide-framing is called upon to bear, this can now, by a judicious placing of material, be immensely lightened and cheapened, so that the difference in cost between gasholders with external guide-framing and the two methods described of dispensing with it has been so greatly reduced that it is very questionable whether the latter will hold their own, much less that the practice in future years will be altogether in favour of gasholders without external guide-framing.

A guide-framing for gasholders (Fig. 77) has been patented and very successfully applied by Cutler & Sons, of Millwall, in which the horizontal ties—except at the top—are omitted, and the stiffness of the uprights depends entirely upon the stays. The same firm have designed an arrangement, which is now largely in use, for carrying the hose-pipe which conveys steam to the cups of telescopic gasholders to prevent the water freezing.

### GOVERNORS.

In conclusion of this article, reference must be made to the plan adopted for reducing the heavy pressures thrown by gasholders to such pressure that gas can be suitably supplied to consumers.

The pressure of gas can be controlled, of course, by simply opening or closing a valve by hand as the demand increases or decreases, but this would be a clumsy plan, depending entirely upon the attention of the operator. To obviate this the governor was invented, in which a valve is supported by the pressure of gas acting underneath the bell of a small gasholder. The pressure of the gas supplied to consumers can then be increased by weighting the crown of the small gasholder. As long as the pressure of the gas at the inlet of the governor is uniform, as it would be when a single-lift gasholder is used, nothing further is required; but when it varies, as it does with multiple-lift gasholders, it is altogether inadequate, and will not insure a uniform outlet pressure. A compensated governor then becomes necessary; that is, the inlet pressure of gas which acts upon the valve must be made to act upon a portion of the bell of the small gasholder of equal area to the valve and in an opposite direction.

Of this description is the Cowan patent

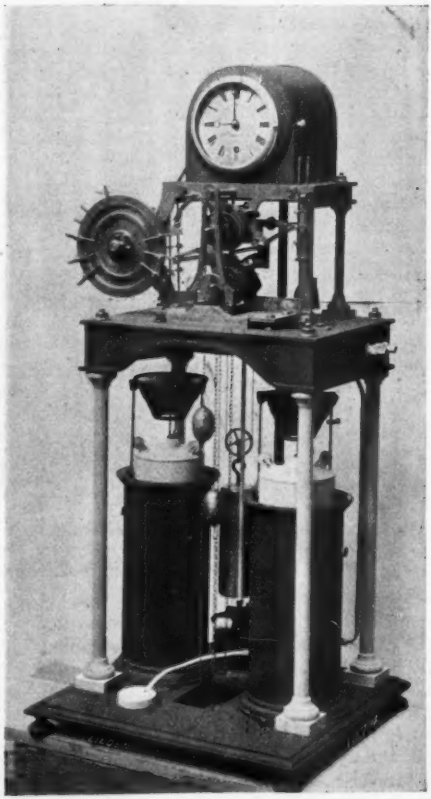


FIG. 79.—COWAN'S PATENT AUTOMATIC PRESSURE CHANGER.

governor (Fig. 78). It consists of the usual bell, or small gasholder, floating in a tank of water, and having a valve suspended from its crown. Into communication with this bell is put the gas after it has passed through the valve. As the gas increases or decreases in pressure beyond what the bell has been weighted to give, so this rises or falls, at the same time closing or opening the suspended valve, the desired pressure being thus automatically maintained. The compensation for changes of inlet pressure is obtained by having a chamber on the top of the bell, into which the inlet gas is introduced through the hollow rod suspending the valve from the crown. This chamber has an equal area to the valve base, so that whatever the upward pressure of gas may be on the valve a similar pressure acts downwards upon the crown of the bell, thus rendering the valve insensible to changes of pressure. It will be seen that when weight is added to the bell the valve will be opened wider, thus increasing the pressure of the gas, and the reverse occurs when the bell is lightened. In the Cowan governor the weight is increased by loading with water, which may be run on as slowly as desired and syphoned off again slowly. By this means the addition or reduction of pressure is imperceptible.

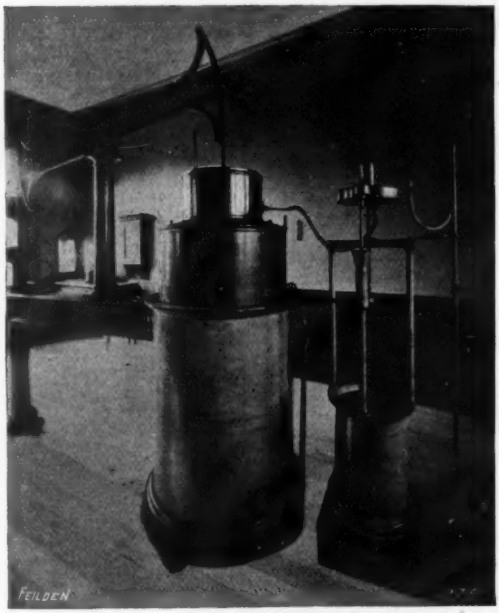



FIG. 80.—BRADDOCK'S PATENT 30-IN. DIAMETER COMPENSATING STATION GOVERNOR, WITH AUTOMATIC SELF-LOADING ARRANGEMENT, AT THE EFFINGHAM-STREET GAS WORKS, SHEFFIELD.

A very ingenious piece of apparatus (Fig. 79) for automatically changing the pressure of gas has been invented by the maker of the Cowan governor, and is largely used in connection therewith. It consists of a clock, having geared to it a disc, which it revolves once in 24 hours. Attached to this disc are two series of tappets, which can be so fixed as to come into operation at any desired period of the disc's daily revolution. One set of tappets controls a cock supplying water to the loading tank on the governor, the other set controls a similar cock withdrawing water therefrom. Shutting off the flow of water, when the required addition or reduction of pressure has been attained, is effected by means of two small gasholders in communication with the outlet gas from the governor. One of these in rising causes the water-supply cock to close; the other, in falling, the syphon cock. The small gasholders can be weighted to rise or fall at any desired pressure.

Another device for loading governors which, within certain ranges, is absolutely automatic, has been invented by J. & J. Braddock, of Oldham (Fig. 80). Unlike Cowan's "pressure changer," it does not load and unload the governor at any set times of the day, but the loading commences automatically whenever the consumption of gas increases, and unloading when it decreases again. This is effected

by fixing alongside the governor a water tank, which acts just as the balance cistern of a low-pressure kitchen boiler does, in maintaining a uniform level of water in the boiler; with this difference, that in the latter case the water in the boiler is reduced in level by being drawn out of the boiler, while in the former the water on the governor is lowered by the bell sinking as the valve of the governor opens to allow an increased quantity of gas to pass. In other words, the governor being set to give a minimum pressure, then, when the consumption of gas increases, the valve must open further to maintain this minimum, and the bell descends, water from the balance cistern is syphoned into the loading tank, thereby increasing the load on the bell, and the pressure is increased. As the consumption of gas reduces, the reverse action takes place, with the result that the pressure is reduced. A difficulty however, occurs, owing to changes of inlet pressure, which causes an alteration in the level of the bell even with a uniform consumption. This, to a considerable extent, is overcome by placing the balance cistern upon the bell of a small gasholder which is similarly affected by the changes of inlet pressure. The arrangement, however, is not perfect where these changes are extreme, and the application of the system is therefore somewhat limited.

Fletcher W. Stevenson

FINIS.

*Correction, p. 397, col. 2, line 17.*

It was stated in the last instalment of this article that the faces of the Weck's valves are made of lead. This is incorrect, as the faces are made of a special mixture in which there is very little lead.

# Pneumatic Tools and Appliances.

By EWART C. AMOS, M.I.Mech.E.

## FURTHER TYPES OF DRILLS.

*(Continued from page 408.)*

EVEN during the short time since these articles were commenced important improvements have been effected in the design and construction of many of the tools referred to, and this is particularly noticeable in respect to drills. The great value of this type of machine is rapidly being recognised, and the many and varied applications to which it lends itself are bringing home to our engineers the value of compressed air as a source of energy.

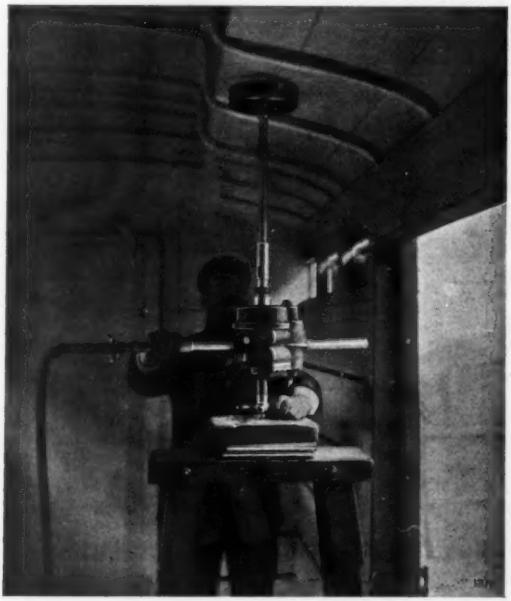


FIG. 56.—"LITTLE GIANT" DRILL APPLIED TO CUTTING LAMP HOLES IN BICYCLE VAN AT THE LONDON AND NORTH-WESTERN CARRIAGE WORKS, WOLVERTON.

Fig. 56 illustrates a very good example of one of the latest applications. This block shews a "Little Giant" Piston Air Drill driving a special saw bit for the purpose of cutting out lamp holes in a bicycle van in the carriage department of the London & North Western Railway Works at Wolverton. This application has only recently been made, and is found to be very successful, the work being done quicker and at less cost, besides giving better results, than when sawn out by hand. As an example of the speed at which a hole can be cut, it takes from 30 to 40 seconds to remove a disc of wood 7in. diameter or allowing for the setting of the machine say about 2 minutes per hole cut.

Fig. 57 shews an application of a "Boyer" Piston Air Drill to the drilling of end-plate furnace flanges of cylindrical marine boilers, with furnace in position. It will be noticed that the drill is mounted on a special revolving frame, which permits of rapid adjustment of the drill and also acts as a holder-up. As an example of speed at which the work can be performed, 54 holes $\frac{15}{16}$ in. in diameter have been drilled in $\frac{3}{4}$ in. steel plate in 1 hour 10 minutes.

Coming now to a description of the drills themselves, Figs. 58, 59 and 60 shew three views of a "Whitelaw" Reversible Drill. Fig. 58, it will be seen, is an outside view, whilst Fig. 59 shews the interior of the

machine with half the casing removed. Fig. 60 is a vertical section, taken to shew the method of reversal and the air passage leading from the supply pipe through the piston valve to the cylinders.

Fig. 58 illustrates a machine fitted with a star centre, whilst the sectional views show a machine fitted with a handle in place of this, and suitable for tube expanding or light drilling, wood-boring, etc., for which the machine is specially suited. The principle on which the drill works is readily seen by reference to the sectional views, in which *A* and *B* are two double-acting oscillating cylinders, driven by means of suitable connecting rods from the crank-shaft *C*, on which is mounted a pinion *D*. This pinion engages with a spur wheel *E*, which is attached to the drill spindle. It will be noticed that the cylinder trunnions are carried in ball bearings, as are also the crank-shaft and drill spindle, and that the casing and handle are made of aluminium. The direction taken by the air is shown by the arrows marked on Fig. 60, and from which it will be seen that air is alternately admitted at either end of each cylinder as in an ordinary double-acting oscillating engine. The method of reversal is as follows:—Attached to the milled handle *F* is seen a bevel wheel, which engages with a small rack *G* formed on the end of the lever *H*. This lever is fulcrummed as shown, and its other end pivots on the part *I* and piston valve (sectioned black). By revolving the milled handle *F*, the part *I* is caused to rock, and thereby causes the cylinders to reverse in the ordinary way. When it is pushed right over in either direction the piston valve is always open for air to pass to cylinders, but when it is in middle position it shuts off the air supply. It may be mentioned that the air exhausts into the casing and escapes from suitable apertures.

FIG. 57.—"BOVER" DRILL APPLIED TO THE DRILLING OF END-PLATE FURNACE FLANGES OF MARINE BOILER, WITH FURNACE IN POSITION.

In the last article, Fig. 55 showed two "Little Giant" drills in operation, and further reference was promised to this class of machine. Fig. 61 shows an outside view of a "Little Giant" No. 1 Piston Air Drill, capable of drilling holes in metal up to 2½ in. diameter, with an air pressure of 80 lbs. per square inch, and using 35 cubic feet of air per minute. In this type of drill the motor consists of four single-acting cylinders arranged in pairs, and having each pair of pistons connected to opposite ends of a double crank-shaft. The pistons of each pair travel in opposite directions at all parts of the stroke, to effect smooth running; they are also of a length equal to 1¼ of their diameter, to

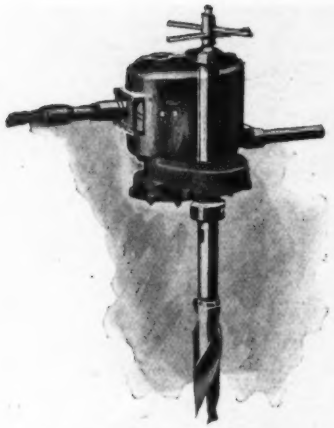


FIG. 58.—"WHITELAW" REVERSIBLE DRILL.

secure an air-tight piston at all times. The crank-shaft is of hardened steel and runs in an enclosed chamber, and is fitted with removable bronze bearings. The chamber is open to the bottom of the cylinder, and may be filled with oil, thus lubricating every part of the machine. The drill spindle is independent of the motor casing, and is carried through on a steel bar. It is also provided with a thread cut on the outside, to which sockets or chucks for reaming and tapping may be screwed.

This type of drill is made in various sizes and designs, and capable of doing all kinds of portable drilling work, and since it contains many interesting and novel features, especially in its reversing attachment, it is proposed to describe it in detail, in connection with sectional views of the various parts, a general description as given above not being considered sufficient to convey the working of the machine. It must also be noted that the machine, shown in Fig. 61, has no reversing arrangement, whilst the line drawings show the latest type, and have, so far, not been published.

Fig. 62 is a perspective view of the "Little Giant" New Reversible Drill; Fig. 63 a central longitudinal section, taken on lines 2–2 of Figs. 64 and 65, looking in the direction of the arrows; Fig. 64 is an elevation of the rear end of the casing with the reversing handle partly broken away, and showing in full and dotted lines the different positions of the handle in operating the instrument;

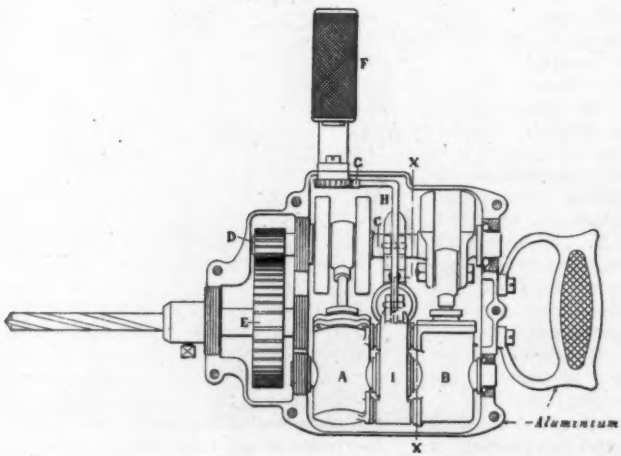



FIG. 59.—INTERIOR OF "WHITELAW" REVERSIBLE DRILL.

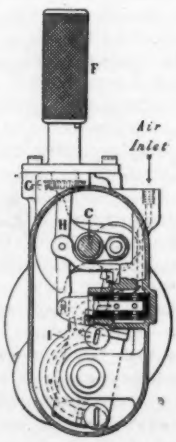



FIG. 60.—VERTICAL SECTION OF SAME.

Fig. 65 is a transverse section, taken on line 4 of Fig. 63 looking in the direction of the arrow; Fig. 66 is a transverse section taken on line 5-*x* of Fig. 63 looking in the direction of the arrow; Fig. 67 is a transverse section, taken on line 6-X of Fig. 63 looking in the direction of the arrow; Fig. 68 is a projected view of the tapered reversing valve; Fig. 69 is a projected view of the casing of the tapered reversing valve; Fig. 70 is a transverse section, taken on line 9 of Fig. 63, looking in the direction of the arrow; Fig. 71 is a transverse section, taken on line 10 of Fig. 63 looking in the direction of the arrow, being in fact an end elevation of the main shell or casing; Fig. 72 is a transverse section, taken on line 11 of Fig. 63 looking in the direction of the arrow; Fig. 73 is a transverse section, taken on line 12 of Fig. 63 looking in the direction of the arrow; Fig. 74 is a diagrammatic view, taken on line 13 of Figs. 63, 66, 67, 70 and 71 looking in the direction of the arrows of Fig. 63; and Fig. 75 is a diagrammatic view, taken on line 14 of Figs. 63, 66 and 67 looking in the direction of the arrow of Fig. 63.

In the drawings *A* is the main casing, which encloses practically all the working parts of the machine. At each side of casing *A* are two cylinders, comprising a rear and front set, *B* $B^1$ being the rear set, and *C* $C^1$ the front set. Each cylinder is a pressure cylinder, and has therein a piston *D*, to which is connected a piston rod $D^1$, the four rods $D^1$ being connected to the crank-shaft, the rods of the rear set of cylinders connect with crank $E^1$ of shaft *E*, and those of the front set with crank $E^2$, the connection and arrangement being one that causes the pistons to act on the crank-shaft at different times and in different positions, so as to avoid what is commonly known as the dead centre. The arrangement is also one which gives successive impulses to the crank-shaft so as to produce the uniform rotation of the same and practically a constant transmission of power and motion from the shaft. The result is obtained by the mode of transmitting pressure to the cylinders, as described later on, by which the pressure is operating on a cylinder of each set at the same time, whilst pressure is being exhausted from a cylinder of each set, so that there is always a pressure from the two diagonally opposite cylinders on their respective pistons being transmitted to the crank-shaft. $A^1$ $A^2$ are respectively the front and rear caps of the casing. Cap $A^2$ has an extension, $A^3$, and this cap with its extension carries the compressed air chamber, the controlling valves for the ports and passages from the compressed air chamber to the pressure cylinders, the inlet and exhaust ports and passages for the air, and the valve controlling these ports and passages. *F* $F^1$ are valve chambers situated on the side of the cap $A^2$ corresponding with the position of the pressure cylinders in the main casing. Each valve-chamber contains a valve *G*, the body of which has a series of flanges *g*, dividing the valve into three annular passages $g^1$, $g^2$, $g^3$; these valves are termed triple valves. Each triple valve has a rod $G^1$ pivoted to its inner end, the rods terminating in a ring *H* which encircles an eccentric $H^1$ on the crank-shaft so arranged as to give the

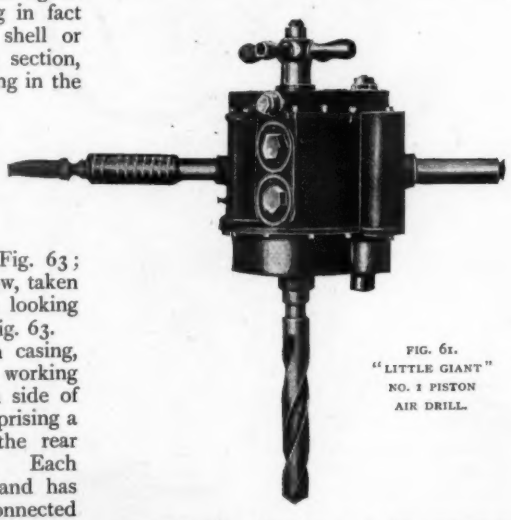


FIG. 61.
"LITTLE GIANT" NO. 1 PISTON AIR DRILL.

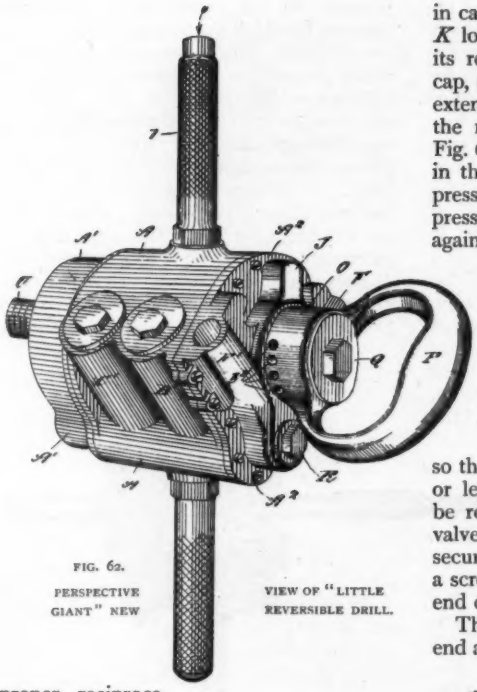


FIG. 62.

PERSPECTIVE VIEW OF "LITTLE GIANT" NEW REVERSIBLE DRILL.

proper reciprocation to the triple valves for controlling the admission of compressed air to and its exhaust from the cylinders. The triple valve in chamber $F$ controls air to and from cylinders $B$ and $C$, and triple valve in chamber $F^1$ controls pressure to and from cylinders $B^1$ and $C^1$. $I$ is the pressure supply pipe connected to the casing and communicating with passage $a$; passage $a$ communicates through a port $a^1$ in cap $A^2$ with a compressed air chamber $K$ located in the head or cap, and having its receiving portion in a wall $J$ on the cap, and the chamber $K$ is continued or extended into a smaller chamber $K^1$ in the neck or extension $A^3$, as shown in Fig. 63. $L$ is a second pressure chamber in the cap and separated from the main pressure chamber $K$ by a wall $L^1$. The pressure chambers $K$ and $L$ are closed against each other—except by means of the ports or passages described later on—by a shell or casing $M$ entered into the cap and its neck or extension, as shown in Fig. 63. The casing $M$ carries a plug or tapered valve $N$, having a central longitudinal passage $N^1$. This plug valve is connected by a screw or pin $u$ with a ring $O$ of handle $P$, so that by turning the handle to the right or left, as may be the case, the valve will be rotated in its shell or bushing. The valve with its bushing and the handle are secured in place on the cap by means of a screw-threaded plug $Q$ entered into the end of the neck, as shown in Fig. 63.

The crank-shaft $E$ has at its operative end a pinion $S$, which engages with a gear-

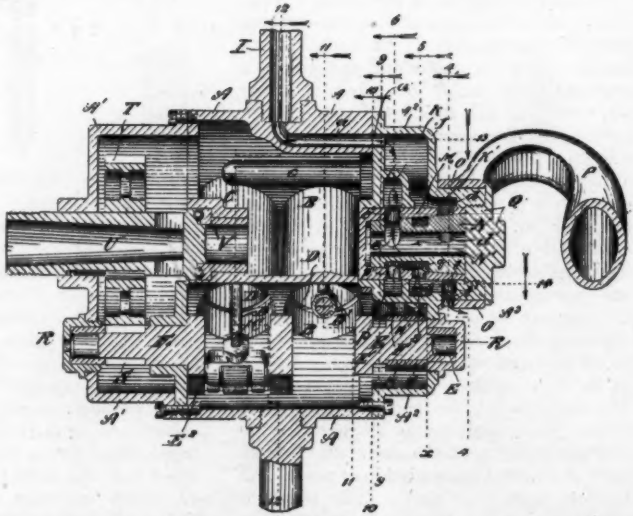


FIG. 63.—LONGITUDINAL SECTION OF "LITTLE GIANT" NEW REVERSIBLE DRILL.

wheel $T$ on the shank of the tool-holder $U$, the rear end of the latter being supported in a bearing $V$. The supply and control of compressed air to the cylinders is accomplished as follows: A passage $b$ is provided in the main shell for each rear pressure cylinder, and a passage $c$ for each front pressure cylinder. These passages communicate, respectively, with ports $b^1$ and $c^1$ formed in the head $A^2$, so that through the passages and ports $b$, $b^1$, compressed air is admitted to and exhausted from the cylinders $B$ and $B^1$, and through the passages and ports $c$ and $c^1$ it is admitted to and exhausted from

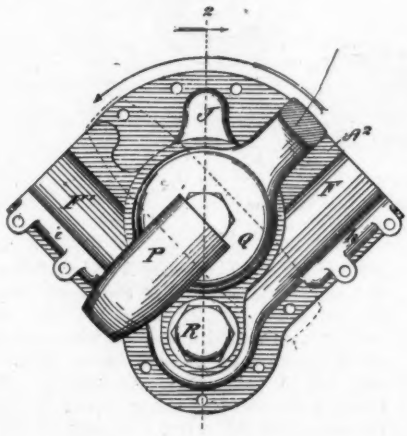



FIG. 64.

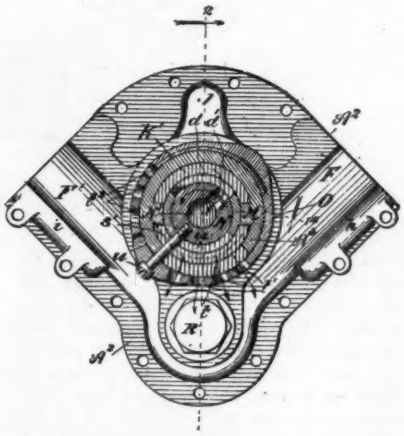



FIG. 65.

ELEVATION AND TRANSVERSE SECTION OF "LITTLE GIANT" NEW REVERSIBLE DRILL.

cylinders $C$ and $C^1$. The bushing $M$ has a slot or passage $d$ in communication with chamber $K^1$ and also in communication with a port $d^1$ in the valve $N$, which port opens into the passage $N^1$, so that air can flow from the chamber $K$ into the passage $N^1$, and the arrangement is one by which air is constantly admitted into the passage $N^1$, for which purpose the slot or recess $d$ is of a length to cover the semi-rotation of the valve for reversing purposes. The air having been admitted into the passage $N^1$, flows through an elongated port or passage $e$ transversely of the valve, which port communicates with a port $e^1$ in the bushing leading into the chamber $L$. At each end of the chamber $L$ is a port or passage, one of which, $f$, communicates with the chamber $F$ of a valve $G$, and the other, $f^1$, with the chamber $F^1$ of the opposite valve $G$, as shown in Fig. 58, so that, with the movements of the valve, air can flow from the chamber $L$ to the cylinders. Adjacent to the chamber $F$ is a passage $h$, which communicates at its outer end with a port $b^1$, and at its inner end with the chamber of the valve $G$ through a port $h^1$, so that with the valve in proper position air can pass from the chamber $L$ to the cylinder $B$. Adjacent to the valve chamber $F^1$ is a passage $i$, which communicates at its outer end with a port $b^1$, and at its inner end with the port $i^1$ leading into the valve chamber $F^1$, so that with the valve $G$ of such chamber in proper position air can flow from the chamber $L$ into the passage $i$ to pass to the cylinder $B^1$.

These passages, $h$ and $i$, with their respective ports $b^1$, $h^1$ and $i^1$, are both inlet and exhaust passages for the cylinders $B$ and $B^1$. With the valves in the position shown in Figs. 66 and 67, the passage

FIG. 68.

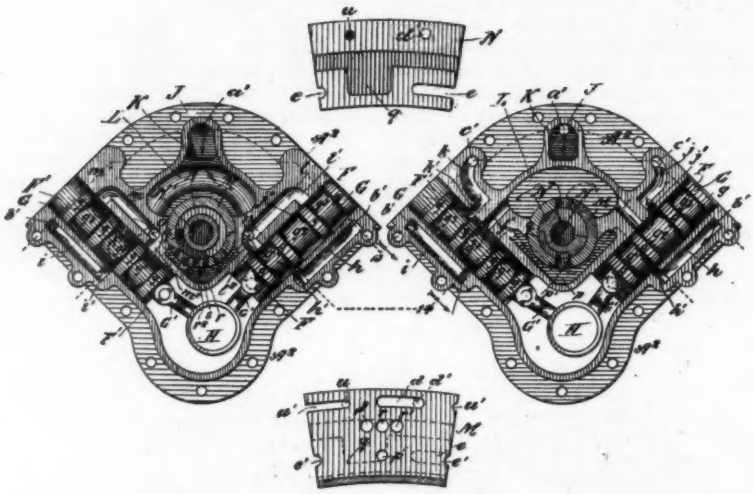


FIG. 66. FIG. 69. FIG. 67.

FURTHER DETAILS OF "LITTLE GIANT" NEW REVERSIBLE DRILL.

*h* is an exhaust passage for the cylinder *B*, and the passage *i* an inlet passage for the cylinder $B^1$, as indicated by the arrows. The valve on the exhaust side has moved to a position where the port $h^1$ is in communication with the passage $g^1$ of the valve, and this passage is in turn in communication with the port $i^2$ of the exhaust passage or port *n* leading to an exhaust chamber. The valve on the inlet side at the same time has moved to a position where the inlet passage $f^1$ is in communication with the passage $g^2$ of the valve, so that pressure flows from the chamber *L* through the port of such chamber, and the passage of the valve into the passage *i*, through the port $i^1$, and thence through the port $b^1$ to the passage *b* of the cylinder $B^1$, supplying pressure to such cylinder to operate its piston, while air is being exhausted from the cylinder of the other or companion piston. The reversal of position of the valves brings the valve on the right-hand side of Figs. 57 and 58 into position to be an inlet valve, permitting pressure to flow through the port *f*, passage $g^2$, port $h^1$, passage *h* and port $b^1$ – to the cylinder *B*, and at the same time the valve on the left hand of Figs. 66 and 67 has reached a position where such valve becomes an exhaust valve, permitting air to pass from the cylinder $B^1$ through the port $b^1$, passage *i*, port $i^1$, and passage $g^1$ of the valve, and port $m^2$ into the common exhaust passage *o* leading to the exhaust chamber. It will thus be seen that the two valves are alternately inlet and exhaust valves, and this change in the operation is obtained by means of the eccentric on the crank-shaft, and is coincident with the movements of the pistons in the respective cylinders *B* and $B^1$ and the action of such pistons on the crank-shaft. Adjacent to the chamber *F* in the cap is a passage *j*, which, at its outer end, communicates with a port $c^1$, and at its inner end, through a port $j^1$, has a communication with the valve chamber *F*. Similarly a passage *k* adjacent to the chamber $F^1$ in the head or cap at its outer end communicates with a port $c^1$, and at its inner end through a

port $k^1$ has communication with the valve chamber $F^1$ in the head or cap. The passage $j$, with its ports, is the inlet and exhaust passage for the cylinder $C$, and the passage $k$, with its ports, is the inlet and exhaust passage for the cylinder $C^1$, according as such passages are opened or closed to the compressed air supply by the movements of the triple valves. As shown in Figs. 66 and 67 the valve on the right-hand side is an exhaust valve for supplying pressure to the cylinder $C$, such pressure flowing through the port or passage $F$, passage $g^3$ of the valve, port $j^1$, and passage $j$, into and through the passage $c$ from the port $c^1$ into the passage $k$ and port $k^1$, passage $g^3$ of the valve into the exhaust passage $m$ to escape through the common exhaust port $o$ in the exhaust chamber. The reversal of the position of the valves brings the valve on the right-hand side of Figs. 66 and 67 into use as an exhaust valve, permitting air to escape from the cylinder $C$ through the passage $c$, port $c^1$, passage $j$, port $j^1$, and passage $g^3$ of the valve into the passage $l$ and the ports $l^1$, and out through the common exhaust port $n$ to the exhaust chamber. At the same time the valve on the left-hand side of Figs. 66 and 67 has been moved to a position where it becomes the inlet valve for the cylinder $C^1$, permitting pressure to flow from the chamber $L$, through the passage $f^1$, into the passage $C^2$ of the valve, and thence through the port $k^1$ and passage $k$ to the port $c^1$, and enter the cylinder by the passage $c$ to exert pressure on the piston of such cylinder. It will thus be seen that the two valves through the action of the eccentric on the crank shaft are also the inlet and exhaust valves for the chambers or cylinders $C$ and $C^1$ for admitting air to and exhausting it from such cylinder co-incident with the movements of the piston and the crank-shaft, precisely the same as with the operation of such valves for the chambers or cylinders $B$ and $B^1$ in supplying pressure to and exhausting it from such chambers or cylinders.

The common exhaust port $n$ for the exhaust from the passages $h$ and $i$, and the common exhaust port $o$ for the exhaust from the passages $i^1$ and $m$, both leading to an exhaust chamber $p$ formed in the cap $A^2$, as shown in Figs. 63 and 67, so that the exhaust from both sets of cylinders is carried to a common exhaust cham-

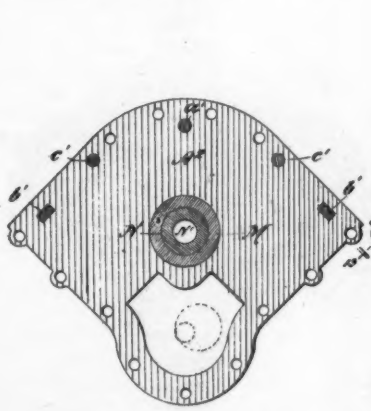


FIG. 70.

TRANSVERSE SECTIONS OF "LITTLE GIANT" NEW REVERSIBLE DRILL, TAKEN ON LINES 9 AND 10 OF FIG. 63.

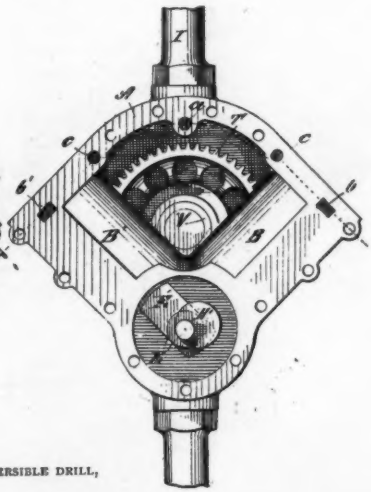


FIG. 71.

ber. A port $p^1$ leads from the common exhaust chamber $p$ and communicates with a lateral passage or recess $q$ in the body of the valve $N$, which passage or recess also extends longitudinally of the valve, as shown in Figs. 63 and 66. The passage or recess $q$ communicates through a port $r$ with a pressure exhaust chamber $f$, and this port is formed in the casing or bushing of the valve. In this casing, transversely on opposite sides of the port, is a port $r^1$ and a port $r^2$, both of which communicate with the chamber $s$ and with the passage or recess $q$. The chamber $s$ has a contracted mouth or portion $s^1$, which communicates with a transverse passage $t$ cut through the wall of the neck or extension $A^3$, and this passage in turn communicates with a series of holes, $t^1$, in the ring or band $O$, when the handle stands in one position, as shown in Figs. 63 or 65, or with holes $t^2$ in such ring or band, when the position of the handle is reversed so as to bring the holes of the ring or band in alignment with the passage $t$.

The fluid pressure exhausted from the respective cylinders flows out through the exhaust passages, as previously described, and enters the common receiving chamber $p$, and from such chamber passes through the final discharge chamber $s$, through the port $p^1$, passage $q$, ports $r$, $r^1$, and $r^2$, discharge passages $s^1$ and $t$, and discharge holes $t^1$ and $t^2$ to the atmosphere. The handle thus controls the inlet and exhaust of the air to and from the several cylinders, and this handle also furnishes the means for reversing the operation of the piston, and, consequently, of the rotation of the crank shaft, giving a reverse movement to the tool. This operation of reversal is effected by turning the handle portion into the position shown by dotted lines in Fig. 64, it being understood that with the handle in the position shown by the full lines of Fig. 64 the crank-shaft is driven to operate the tool. The turning of the handle into the position shown in dotted lines does not affect the transmission of pressure to the cylinders, as with such change in position the passage $d$ and the ports $d^1$ are still in communication for air to flow through the various ports and passages, as already described,

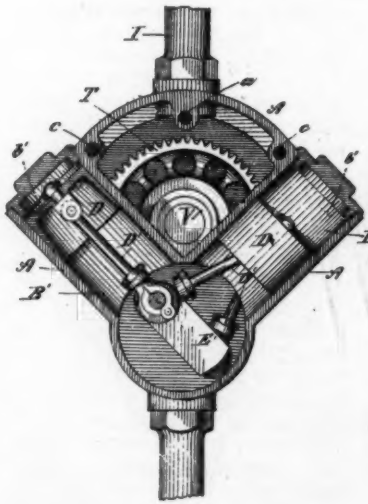


FIG. 72.

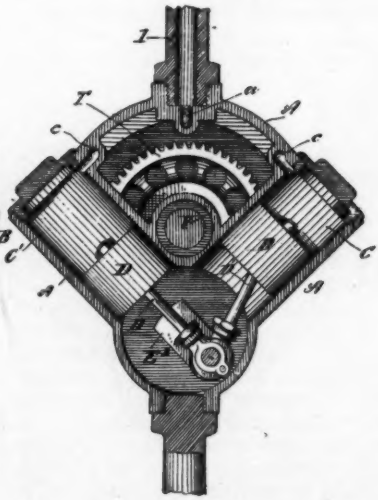


FIG. 73.

TRANSVERSE SECTIONS OF "LITTLE GIANT" NEW REVERSIBLE DRILL TAKEN ON LINES 11 AND 12 OF FIG. 63.

to supply pressure to the cylinders, but with such change of position the application of the pressure is reverse from its application with the handle in the position of the full lines, producing the reverse reciprocation for the pistons of the cylinders, and consequently a reverse rotation for the crank-shaft and the tool. The pressure is exhausted from the cylinders through the various ports and passages as described, except that with the change of position of the handle the final discharge hole $f^2$ comes into position to exhaust the pressure to the atmosphere. The movement of the handle simply moves the controlling valve $n$ into a different position, but without changing the relation of such valve to the supply ports and passages and likewise without changing its relation to the exhaust ports and passages, except as to the ports $r^1$ and $r^2$, which are operated according as the position of the valve is changed. The semi-rotation of the valve is permitted by reason of the elongated recess $u^1$ in the casing or bushing $N$, through which the stem of the pin or screw $u$ passes, as shown in Fig. 63.

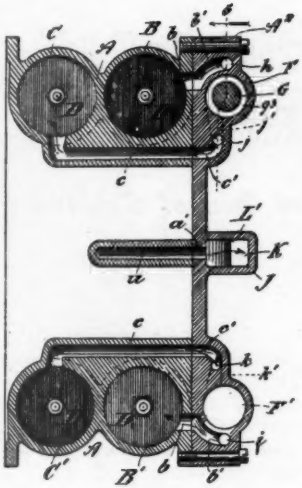


FIG. 74.

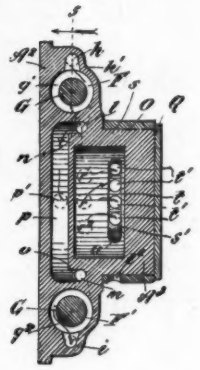


FIG. 75.

DIAGRAMMATIC VIEWS OF "LITTLE GIANT" NEW REVERSIBLE DRILL.

It should be noted that with this system of valve gear it is possible to make an early cut-off of the air supply, and in fact the valve cuts off at about $\frac{5}{8}$ of the stroke, which effects considerable economy in the amount of air consumed. In the next article further types of drills will be considered and illustrated, together with photographs showing their various applications. These will be followed by reference to other Pneumatic Tools not yet dealt with.

(*To be continued.*)

Ewart & Amos

# The Building of a Great Railway.

## The Great Central Extension to London.

*(Continued from page 426.)*

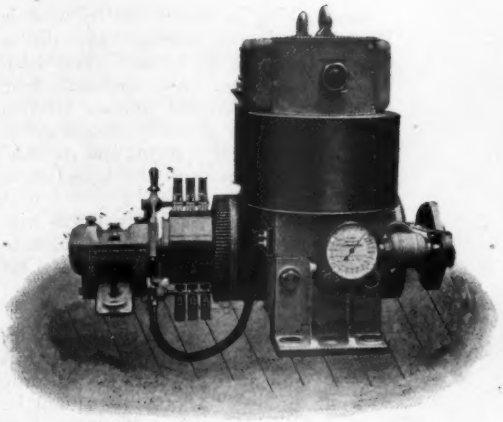
❀ ❀ ❀

THE principal goods and passenger stations are lighted throughout by electricity, the majority of the lamps used being of the differential type. They are fitted in many instances with Royce's Arc Lamp Elevating Gear, the great advantage of which apparatus consists in the fact that, by its use, a lamp may be lowered any distance by means of a cord and winch without the cables festooning down to it in the objectionable and inconvenient manner hitherto in vogue.

A number of the generating dynamos have been supplied by Messrs. Royce, Ltd., of Manchester. These machines have several special features and, as will be seen from the illustration, are of the "Inverted" type. They have each been designed for an output of 60 kilowatts at 110 volts at a speed of approximately 385 revolutions per minute. The field magnets are shunt wound, the connectors being so arranged as to permit of the machines being separately excited

TYPE OF ARC LAMP USED FOR LIGHTING THE PRINCIPAL GOODS AND PASSENGER STATIONS.

ROYCE'S ARC LAMP ELEVATING GEAR.



TYPE OF DYNAMO SUPPLIED BY MESSRS. ROYCE, LTD., TO THE GREAT CENTRAL RAILWAY CO.

from the bus bars on the switchboard to enable them to be run in parallel. Each dynamo is direct-coupled to, and driven by, a separate high-speed "Raworth Universal" steam engine.

The signalling contract, which was one of the largest that has been carried out for many years by one firm, was placed with the Railway Signal Co., of Fazakerley, Liverpool, who successfully laid out the plans and method of doing the work under the different contracts, and overcame the by no means small difficulty of having to get the materials conveyed to the site of erection by carting, trolleying, and wagons.

The work was completed in time for the opening of goods traffic in July, 1898, and also for the opening for passenger traffic in March, 1899.

The following is an approximate summary of the work carried out on the new line, the length of which is about 94 miles, commencing at Annesley, and terminating in London at the New Terminus Station, Marylebone: 75 cabins and apparatus, containing 2,850 levers, 900 signals, 330 ground discs, 13 special bridges of signals, containing 120 arms.

The sizes of the largest cabins are as follows: Nottingham North Cabin, 53 ft. × 11 ft., elevated 8 ft., containing 100 levers; Nottingham South Cabin, 50 ft. × 11 ft., elevated 7 ft., containing 95 levers; Leicester Station North Cabin, 37 ft. × 12 ft., elevated 11 ft., and containing 60 levers; Leicester Station South Cabin, 35 ft. × 12 ft., elevated 9 ft., containing 55 levers; Woodford North Junction Cabin, 44 ft. × 12 ft., elevated 8 ft., containing 76 levers; London Goods Yard Cabin, 59 ft. × 12 ft., elevated 8 ft., and containing 110 levers; Marylebone Station Cabin, 54 ft. × 12 ft., elevated 8 ft., containing 100 levers.

### CABINS, APPARATUS, &c.

At Annesley a large number of sidings are laid down for the sorting and marshalling of trains, also engine sheds, etc., and the signals required for this work are controlled by six signal cabins.

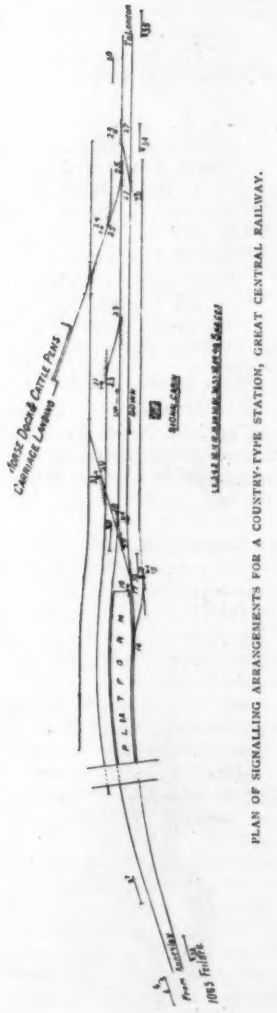
At Nottingham the signalling arrangements are controlled by four signal cabins, a similar number also existing at Leicester.

A line sketch of Ruddington Station, with all the signals shown thereon, is given as being a representative type of nearly all the roadside stations.

The London terminal station involved some very extensive signalling arrangements, controlled by five signal cabins, which enables the traffic in and out of the station to be easily and quickly dealt with, each operation being signalled and protected.

Extensive sorting sidings and junctions are laid in at Woodford (where a connection is made with the East and West Junction Railway Company), and these are signalled and worked by nine signal cabins.

The cabins are built in brickwork, with the exception of where the cabins come on an embankment, these requiring special timber understructures. Each cabin is provided with a separate lamp room, also a coal and ash place.




PLAN OF SIGNALLING ARRANGEMENTS FOR A COUNTRY-TYPE STATION, GREAT CENTRAL RAILWAY.

Interlocking is carried out by what is known as "tappet locking," and this is the standard type the Great Central Railway have adopted. Any special locking can be easily adopted to this kind of locking, and it is generally recognised as being the best. It is strong and durable, with direct action from the lever on to the locking bars.

Each main-line signal is fitted with wire adjusters, enabling the signalman to adjust them without having to leave his cabin.

All main-line signals are specially interlocked to give more protection to trains, as follows:—When the home signal is lowered for a train to enter the platform, and put to danger again, this cannot be given again until the starting signal in advance has been lowered to allow the train to proceed, and put back to danger again, and so on, right through the line, each cross-over road being provided with a shunting disc at each end.

A separate bar is provided for each facing point, and worked by a separate lever, and the points have detectors fixed thereto, controlled by each signal running over the facing points.

The whole of the work was carried out under the superintendence of the Great Central Railway Company's representative, Mr. Thomas Wharmby, who ably assisted in arranging the signalling, and special suggestions made by him have been carried out—one speciality being that ground discs controlling cross-over roads should replace special locking on the home signals; that is, if a train should shunt from the up line to the down line, the down home signal would be locked until the disc for the train to go back again was lowered and put to danger again, this being an additional protection while a train is shunted, and *vice versâ* from the down to the up road.

The signalling arrangements gave every satisfaction to the inspecting officer of the Board of Trade, who expressed his approval of the manner and system in which the work had been carried out.

The bulk of the stations being "island platforms," the sighting of the signals has been rendered very difficult, but these

have been overcome very satisfactorily, giving both signalman and the drivers excellent views of the signals.

Another improvement to make the working as safe as possible consists in an extra connection attached to every ground disc from the switch, this connection being for the purpose of putting back the disc to danger in case of there being an obstruction on the wire occurring accidentally. This ensures the disc always being put to danger when the points are put back, preventing the disc standing off when the points are in their proper position.

Other specialities adopted by the Great Central Company in connection with the signalling arrangements consist in watertight electric bells for use in signal cabins, platforms, etc., and watertight treadles, the particular function of which is to indicate to the signal cabin that a train has cleared a certain section in cases where through running a curve, or from some other cause, the train is not visible from the signal cabin. These installations were carried out by Mercier's Patents Ltd., whose apparatus is so widely appreciated by railway engineers.

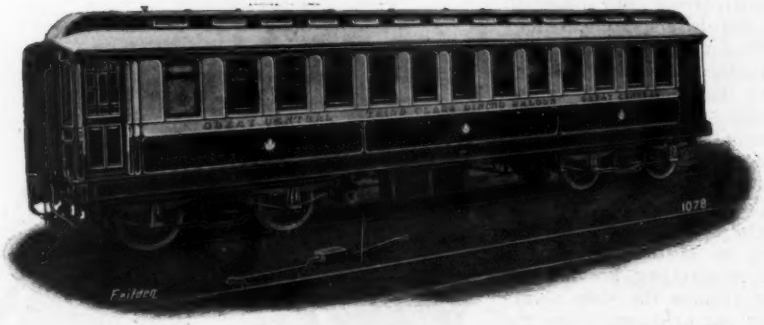
DOUBLE SLIP ROAD, CENTRAL STATION, NOTTINGHAM, BY JOHN TAYLOR AND SON, LTD., NOTTINGHAM.

Having thus traversed the ground covered by this new highway from London to the north, giving particulars of its construction, and showing what facilities exist for establishing a closer link between the capital and the industrial centres of Yorkshire, Lincolnshire, Lancashire and Nottingham, it only remains to give a brief description of the rolling stock to close this series of articles.

The Great Central Railway Company, in possession of one of the finest permanent ways possible, and having adopted a policy of thoroughness which has placed them in possession of every modern facility for safe, economic and rapid working, determined to carry it through to a logical conclusion by equipping the line with a rolling stock second to none on any other railway system in the United Kingdom. To meet the demands created by the opening of the new line the directors have spent over a million and a quarter of money in providing new locomotives of the best and most powerful type, carriages, saloons, corridor trains, etc., necessary for dealing with the various classes of railway traffic. The carriages have been designed with a view to meeting in every possible way the comfort of the travelling public, and in this respect the directors have been undoubtedly successful, as the coaches are of a most handsome and luxurious character, and replete with everything requisite to ensure that comfort which is so essential in long-distance journeys.

Each of the express trains is composed of corridor vehicles, with vestibule connections between the carriages.

The dining and luncheon trains consist of a brake first, composite, first-class dining car, kitchen car, third-class dining car, third-class and brake third.




THIRD-CLASS DINING SALOON (EXTERIOR)

The first-class dining cars, third-class dining cars, and the kitchen cars, are lighted by electricity; the remainder of the vehicles are lighted by oil gas, with Coligny lamps. The first-class dining cars are 50 ft. long over the platforms, each providing accommodation for 20 passengers, the internal fittings are sumptuous, and finished in rare woods, upholstered in figured plush, and embellished with works of art, the roofs being decorated in gold and colours. The seats and tables are placed at the sides, with a passage down the centre, the seat heads being of Spanish mahogany, relieved with carvings, fretwork, and satinwood raised panels, and bordered with Coromandel wood. Over each table is placed the electric communication, and above are alcoves fitted with bevelled-edged mirrors for holding glasses, bottles, etc. A hat-rack is provided over each seat back, and an umbrella-rack to each seat head. The ends of the compartments are panelled, moulded, and carved to match, and relieved with proof etchings, whilst the doors of these compartments are beautifully inlaid with marquetry of artistic design. Another car is

THIRD-CLASS CORRIDOR CARRIAGE.

finished in olive wood, but exactly of the same design, which is part Chippendale and part Adams; and there is one finished in mahogany of Adams and Queen Anne style. The third-class dining cars are externally of the same design, with the exception that they are 41 ft. 6 in. over the platforms. The interiors are finished in light oak and in light and brown oaks. As in the first-class cars alcoves are placed above the tables as well as at the ends are finished inside and outside with bevelled-edged glass doors, and the whole of the side-lights are of bevelled-edged glass in teakwood frames. The lavatories are placed at the ends, and are fitted with Jennings' water-closets and Beresford's wash basins, with a dado finished in mahogany or teakwood match-boarding, and the walls covered with Emdeca. A space is also provided for handbags, etc. The kitchen car, which is

FIRST-CLASS DINING SALOON (INTERIOR).

electric light and communication, with brackets for holding glasses, bottles, etc. The ends of the compartments are finished to match, and relieved with photographs placed over the seat backs. The floors are carpeted, and the roofs are covered with lincrusta carefully picked out and decorated. These cars provide accommodation for 36 passengers, and are constructed with clerestory roofs having stained glass lights. The platforms placed between the first and third-class dining cars, is 47 ft. 6 in. long, and will, by means of the connecting gangways, serve both classes of passengers. In addition to the kitchen and attendants' compartments, a special feature of this car is that it possesses two first-class private dining compartments. The cooking is done by means of a Fletcher and Russell's gas range.

The corridor carriages are externally of

THIRD-CLASS DINING SALOON (INTERIOR)

one uniform height and design, their length being 46 ft. 6 in. over ends, each being divided into compartments with side corridors, which are lighted by large plate-glass lights protected by neat brass handrails. The first-class carriages are finished in Spanish mahogany, and relieved with gold. The ends of the corridors are framed, panelled, and moulded in the same rich wood and fitted with bevelled-edged mirrors and carvings. In the corners are placed filters for the use of passengers, and at the entrances to the vestibules are hung doors with bevelled-edged glass panels. Leading from the corridor at each end are placed ladies' and gentlemen's lavatories, the floors of which are inlaid with mosaic tiles, and the walls covered with pegamoid and matchwood dado. They are also fitted with a Jennings water-closet, Levick's washbasin, water bottles, towels, and other toilet necessaries. The interiors of the compartments are trimmed in morocco moquette, terra-cotta cashmere, velvet, and green cloth, finished in mahogany, and decorated with photographs of places of interest on the Company's system. The third-class carriages are of similar design, except that they are finished in polished teakwood with lincrusta panels and dado. The compartments are fitted with spring seats and backs, with arm rests trimmed in rep, the door panels with vulcan cloth.

All the carriages are provided with portable tables placed at the ends of corridors, which can be readily fixed in position, and in any compartment as desired. In all cases the electric communication between passengers and attendants is placed immediately over each seat back, and in the corridors are alarm signals for the use of passengers in case of emergency. The whole of the floors

are covered with figured cork matting, and a rug is furnished, in addition, to each first-class compartment. The buffet cars are externally of the same length and design, and consist of a spacious buffet, with kitchen, three third-class compartments, attendants' compartment, and lavatory. The buffet is panelled and moulded in figured Spanish mahogany, and relieved with proof etchings and bevelled mirrors. The roof is covered with lincrusta, specially designed, with a border, and picked out in gold. The compartments and lavatory are furnished and fitted exactly the same as the thirds, already described. The attendants' compartment is completely furnished, and also the kitchen, which has a gas range and all utensils.

The difference as between the first-class and third-class carriages is, it will be seen, but one of degree, passengers enjoying throughout perfect equality in all respects affecting their comfort and welfare. As the train speeds along they can enjoy the ever-changing panorama of the landscape from the windows of the side corridors, extending from end to end of the train, and affording a promenade of upwards of 300 ft. in length. Moreover, the monotony of the journey can be pleasantly relieved by luncheon served from the buffet and kitchen cars, with a cuisine which it is intended shall be equal in all respects to that of a first-class hotel. By means of the connecting gangways, attendants will also be enabled to supply passengers with other light refreshments, such as tea, coffee, etc.

The Company have adopted new colours for the exterior of their carriages, which render them in appearance not unlike those of the London and North-Western Company. The upper panels are French grey and the lower panels brown, varnished and picked out with gold lines, lettered and emblazoned with the Company's new coat-of-arms granted by the College of Heraldry. The whole of the carriages have been carefully designed by and built under the direct supervision of Mr. T. Parker, jun., the Company's Carriage and Wagon Superintendent.

The engines have been built to the designs of the company's locomotive and marine engineer, Mr. Harry Pollitt, M.Inst.C.E., M.Inst.M.E., and comprise four-wheel coupled bogie engines with tenders for express passenger service, four-wheel coupled tank engines for local passenger service, and for the goods and mineral trains six-wheel coupled engines with tenders, as well as tank engines, and their leading features are as under :—

Dealing in the first place with the bogie

BUFFET CAR (INTERIOR).

KITCHEN CAR (INTERIOR).

express engines, the firebox is of what is known as the "Belpaire" type, a form possessing many advantages over the ordinary type, notably in that a greater steam space is obtained, and there is less liability to incrustation forming on the firebox top and around the roof stays, and better facilities for washing out and removing any sediment there may be are afforded. There is a greater area for disposition of the firebox fittings, and longer life obtained from the tube plates, as there is not the same tendency for the material to give way between the tube holes.

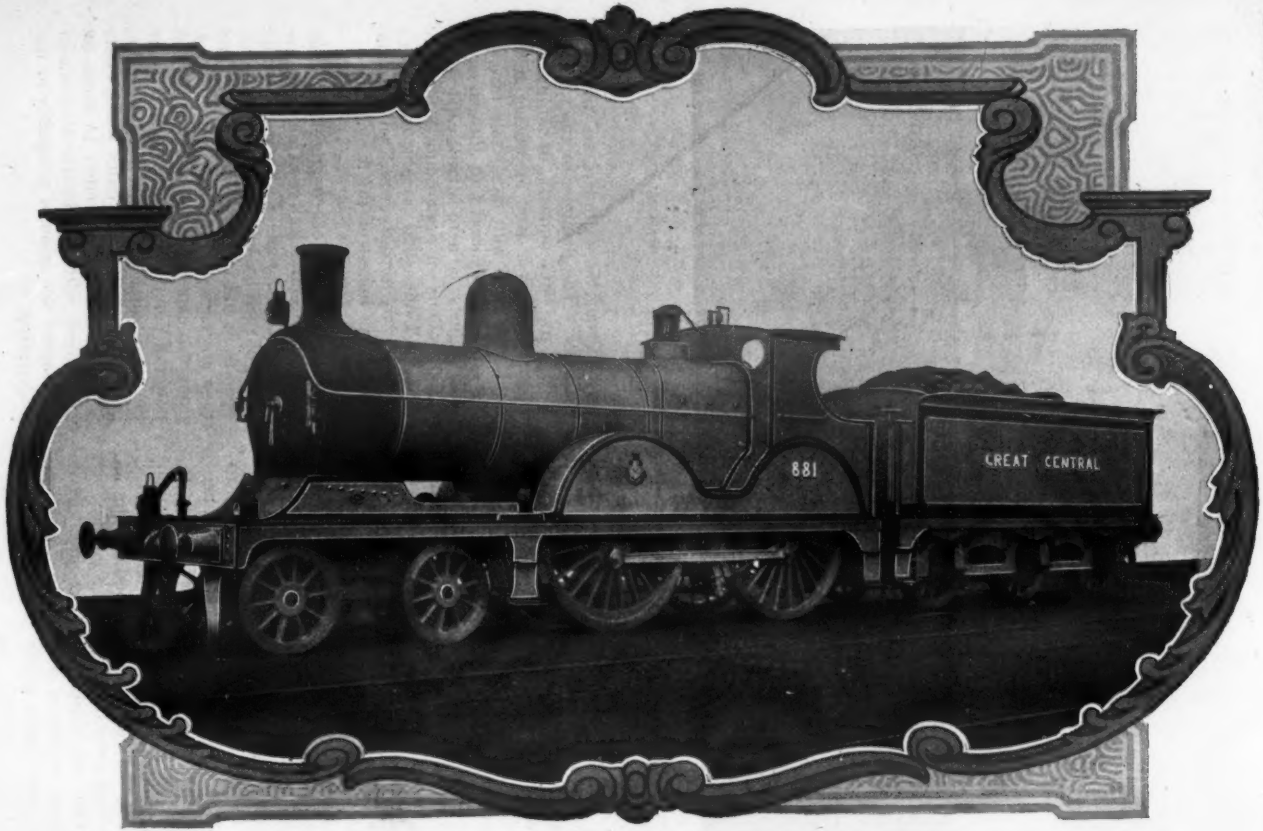
The boiler and firebox shell plates are of "Siemens-Martin" steel, and the inside firebox of copper, the usual deflector plate and firebox arch being made use of. The working pressure of the boiler is 170 lbs. per square inch, cylinders 18½ in. diameter × 26-in. stroke. In these engines the old-fashioned slide valves are replaced by what are known as "piston valves," fixed below the cylinders, and by means of which the wear and tear on the link motion is, on account of the small amount of friction, reduced to a minimum, with, of course, a corresponding reduction in coal consumption.

The engine driving and trailing wheels are 7 ft. diameter, and those of the bogie, which carries the front end, 3 ft. 6 in. diameter. The tenders carry 4,000 gallons of water and 5 tons of coal on three pairs of wheels 4 ft. 3 in. diameter each. All the wheel centres are of cast steel, and the tyres, axles, and crank-pins are of "Siemens-Martin" steel, as also the slide bars.

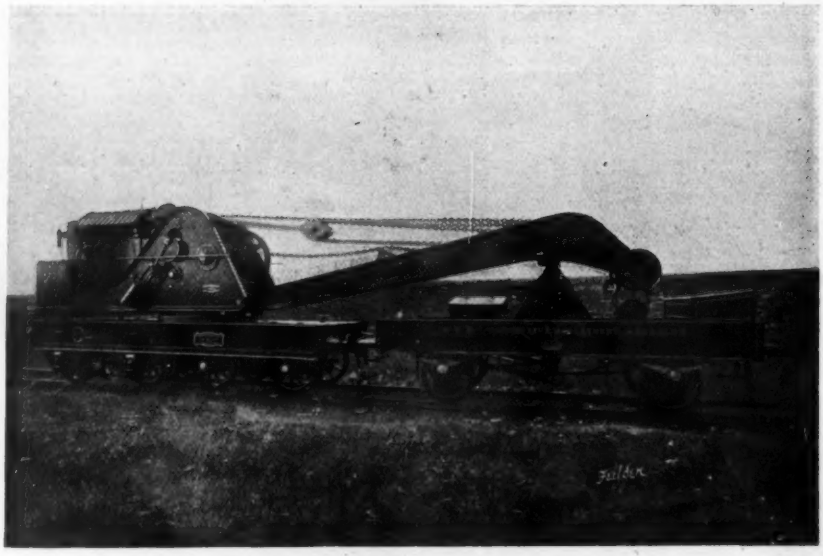
The usual intermediate side buffers between engine and tender have been dispensed with, and their places taken by a large central spring resting in two castings, one on the engine and the other on the tender. The central buffer arrangement is found to effectually prevent any loose or jerky motion between the engine and tender, and, at the same time, it reduces flange friction, and entirely obviates leaky feed-water connections.

The engines are fitted with the vacuum automatic brake, a steam sanding apparatus, and an apparatus by means of which steam is supplied to the storage heaters in the carriages, thus securing for passengers when travelling warmth and comfort. The total length of engine and tender over buffers is 54 feet, and the weight in working order 88 tons 16 cwts.

The passenger tank engines have cylinders 18 in. diameter by 26-in. stroke, with boiler, firebox, brake, etc., similar in




LATEST TYPE OF FOUR-WHEEL COUPLED G.C.R. EXPRESS LOCOMOTIVE, DESIGNED BY MR. HARRY POLLITT, M.I.C.E., M.I.MECH.E.



BREAK-DOWN CRANE OF THE LOCOMOTIVE DEPARTMENT AT ANNESLEY.

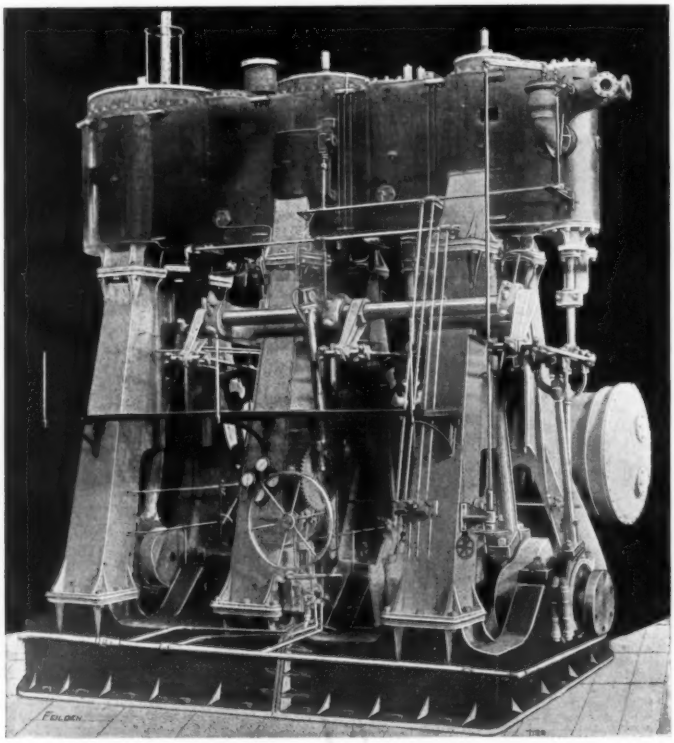
all respects to that already described. The coupled wheels are 5 ft. 7 in. in diameter, and at each end of the engine is a pair of wheels with radial axle boxes, which allow the necessary movement for rounding curves easily. The tanks carry 1,400 gallons of water, and there is space in the bunkers for 2½ tons of coal. These engines in full working order weigh 59 tons, and the total length over buffers is 37½ ft.

Coming now to the goods engines, those with tenders are designed for running long-distance goods trains, and have cylinders 18½ in. by 26-in. stroke, with steam-chest and valves on the top, actuated by a rocking shaft carried from brackets fixed to the slide-bar bracket, and coupled to what is known as the ordinary "Stephenson" link motion. The wheels are 5 ft. 1 in. in diameter, three pairs coupled. The tender carries 4,000 gallons of water and 5 tons of coal, the total weight in working order being 85 tons 6 cwts.

The side-tank goods engines have boilers, fireboxes, motion, etc., identical with the larger goods engines just described, but the cylinders are of 19 in. diameter. The diameter of the wheels is 5 ft. 1 in. (six coupled), in addition to which there is a pair of wheels at the hind end fitted with radial axle boxes of the same type as used with the passenger tank engines. There is tank capacity for 1,400 gallons of water and 2½ tons of coal, and the total weight in working order is 59 tons 8 cwts., with a total length over buffers of 36½ ft.

It is a subject of congratulation that the Great Central Railway Company now possess a line, replete with every equipment, of such magnitude and importance, open from end to end for public use; and they are certainly entitled to the belief, from the experience of other large and powerful companies whose systems enter the metropolis, that they will secure a due proportion of that vast traffic which exists within the limits conceded to them by Parliament, with the beneficial result of an assured accession of prosperity to the undertaking.

SUP



TRIPLE-EXPANSION ENGINES OF THE S.S. "MANCHESTER CORPORATION" AND "MANCHESTER COMMERCE."

*Built by* SIR CHRISTOPHER FURNESS & CO., LTD., *Westgarth.*

# Machinery, Appliances and Processes.

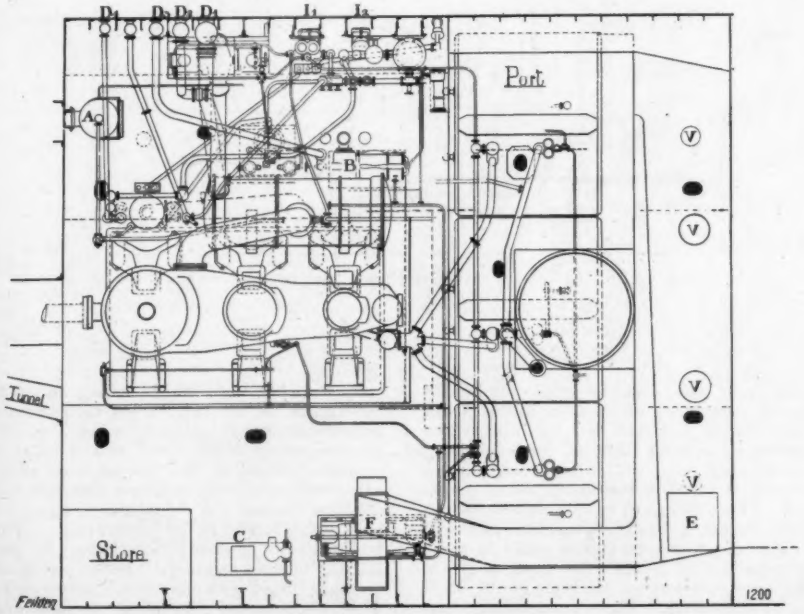
"Every part and side of our life, from the cradle to the grave, has been touched and tended by the inventor and manufacturer. His works are as numberless as the sands of the sea, but the onward rush of Science and the Arts opens up new fields of discovery and enterprise as each day dawns. Let us choose here and there among thousands, and in choosing take the best as far as in us lies."

## TRIPLE-EXPANSION ENGINES.

### SS. "MANCHESTER CORPORATION" AND "MANCHESTER COMMERCE."

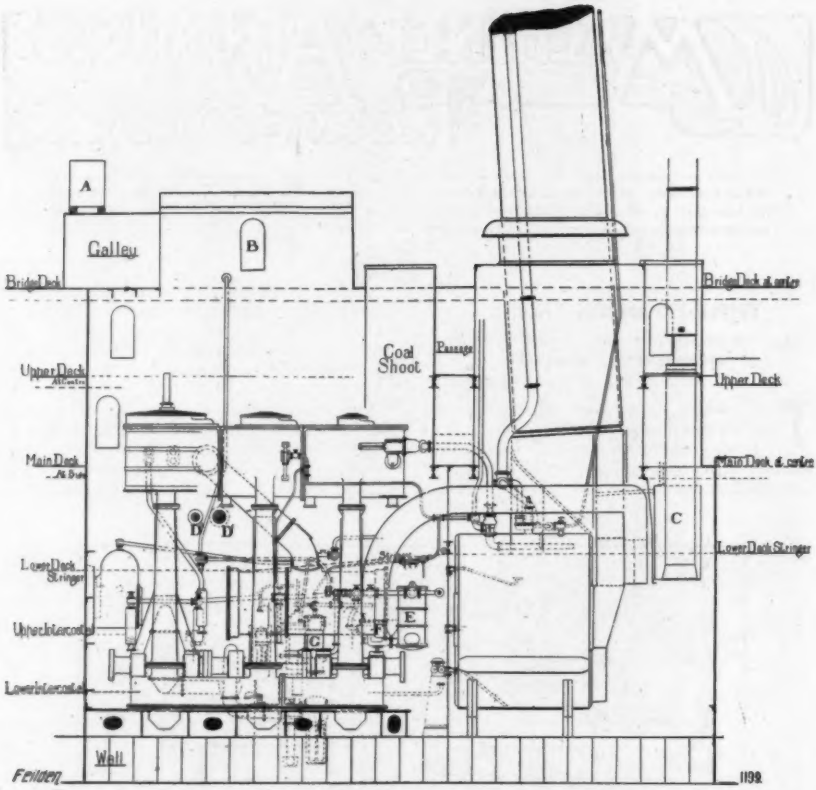
THE special supplement plate presented with this issue illustrates a fine set of triple-expansion surface-condensing marine engines which have been built by Sir Christopher Furness, Westgarth & Co., Ltd., of Middlesbrough, for the ss. *Manchester Corporation* and *Manchester Commerce*, belonging to the fleet of the Manchester liners trading between Canada and Manchester.

The engines are of the ordinary inverted three-crank type, having cylinders 28 in., 46 in., and 78 in. diameter × 54-in. stroke; the piston and connecting rods are extra large, made of best selected scrap iron; double gun-metal bushes are fitted to the top end of the




ENGINES OF THE SS. "MANCHESTER CORPORATION" AND "MANCHESTER COMMERCE": PIPE PLAN.

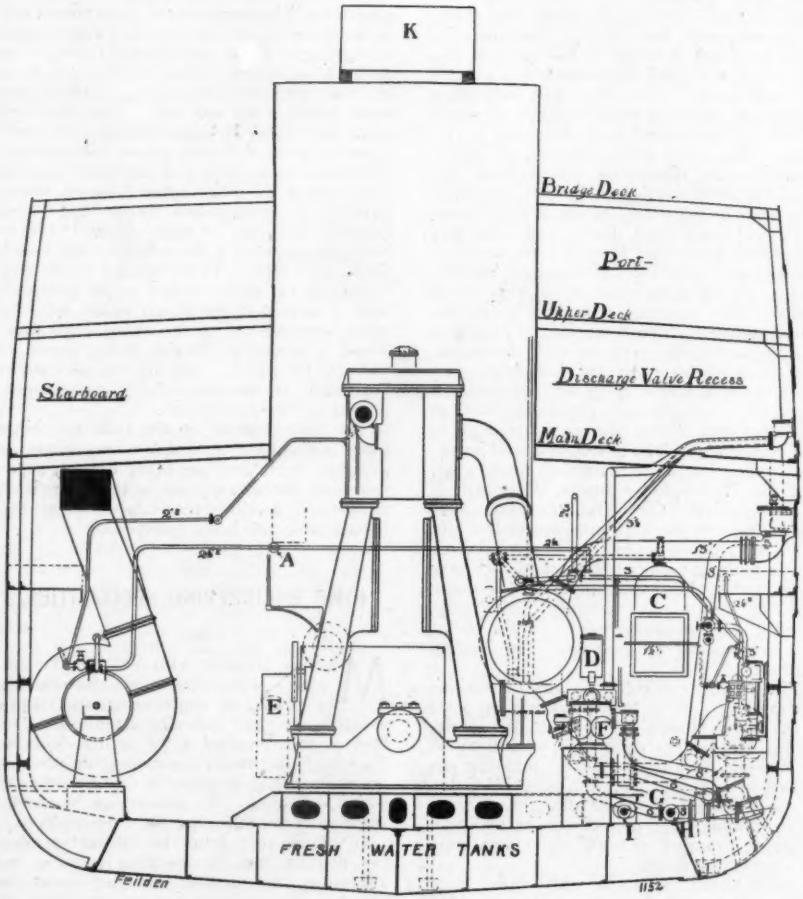
| | | |
|---|---|---|
| *V* Ventilators. | *D1* Main discharge. | *I1* Main inlet. |
| *C* Dynamo. | *D2* Centrifugal discharge. | *I2* Tank filling. |
| *E* Exhaust tank. | *D3* Ballast discharge. | *A* Evaporator. |
| *F* Fan. | *D4* Bilge discharge. | *B* Ballast pump. |




ENGINES OF THE SS. "MANCHESTER CORPORATION" AND "MANCHESTER COMMERCE": PIPE PLAN.

*A* Fresh-water tank.
*B* Door in starboard side.
*C* Exhaust tank starboard side.
$D^1$ Main discharge.
$D^2$ Centrifugal discharge.
*E* Heater.
*F* Filter.
*G* Feed donkey.

connecting rods, and the crank-pin bushes are of cast steel lined with white metal. Each piston rod has two cast-iron shoes with large bearing surfaces, the head-going shoes being lined with white metal, and a tail rod is fitted to the low-pressure piston rod. The crank shaft is of best forged iron 16 in. diameter, which is greatly in excess of Lloyd's requirements, and is made in three interchangeable pieces; the crank pins are the same diameter as the body of the shaft and 17 in. long. The cylinders are cast separately, securely bolted together, and are fitted with deep pistons and covers, the high pressure having a separate liner of cast iron and specially constructed piston valve with extra wide bearing surfaces, taking steam in the centre of the valve; the intermediate and low-pressure cylinders are fitted with double ported slide valves, and a balance piston is fitted to the low-pressure slide-valve rod. Six very massive cast-iron box columns support the cylinders, those at the back being forked at the bottom ends. The bed plate is a strong box-casting in two pieces, bolted together, having six main bearings fitted with cast-iron bushes lined with white metal; polished wrought-iron keeps and strong fine-thread steel bolts secure the bushes in position. The condenser is a circular cast-iron chamber, placed fore and aft on brackets upon the back columns,




ENGINES OF THE SS. "MANCHESTER CORPORATION" AND "MANCHESTER COMMERCE": PIPE ARRANGEMENT, LOOKING AFT.

*K* Fresh-water tank.
*A* Exhaust from reversing and turning engines.
*C* Evaporator.
*D* Weirs.
*E* Tunnel.
*F* Ballast pump.
*G* Sluice (two).
*H* Main tank pipe.
*I* Main bilge pipe.

fitted with Muntz metal tube plates and brass tubes secured by screwed brass ferrules and cotton tapes, and having over 4,000 sq. ft. of cooling surface; a separate centrifugal pump driven direct by two engines, each capable of doing the work, circulates water through the condenser; a large air pump is fitted at the back of the low-pressure engine, from which it is worked by steel levers; two feed and two bilge pumps are bolted to the side of the air pump chamber, and worked from the same cross-head. The valve gear consists of double eccentrics and double bar link motion; the eccentric rods work in line with the valve gear when in full gear, and are of forged iron fitted with cast steel double top ends and adjustable gun-metal brasses; the eccentric sheaves are extra wide, of cast iron, and the straps are of cast steel lined with white metal. The reversing gear is a quick all-round steam and hand motion, so arranged that it cannot be overrun and damaged; the reversing levers are of cast steel, each fitted with a notching-up arrangement; a powerful steam turning engine is fitted at the after end of the bed plate, arranged to run either way. The piston-rod and valve-rod stuffing boxes are fitted with wheel gear, and Sir Christopher Furness, Westgarth & Co.'s improved "Cleveland" metallic packing is fitted to the high-pressure piston and valve-rod stuffing boxes.

The bearing surfaces throughout are very large, and the lubricating pipes, &c., of ample size for continuous running. The stop, throttle and auxiliary valves, drain cocks, &c., are worked by gear from the starting platform.

The engines run about seventy revolutions per minute, and at this speed develop 3,000 h.-p. Steam is supplied by three large single-ended steel boilers, each 14 ft. 9 in. diam. × 12 ft. long, working at 190 lb. pressure per square inch, under Messrs. James Howden & Co.'s system of forced draught, and an 84-in. double inlet fan, driven by two 7-in. engines, arranged to work either separately or together, is fitted.

Each boiler is fitted with three large patent suspension furnaces, and lap-welded wrought-iron tubes, 2½ in. diam., 8 ft. 3 in. long, between tube plates, wide water spaces being arranged between the tubes for efficient steaming; retarders are also fitted in the tubes. Special arrangements have been made in designing the boilers that ample space is left for cleaning purposes, manholes and mudholes being provided where necessary, and the total heating surface in the three boilers is 7,120 square feet.

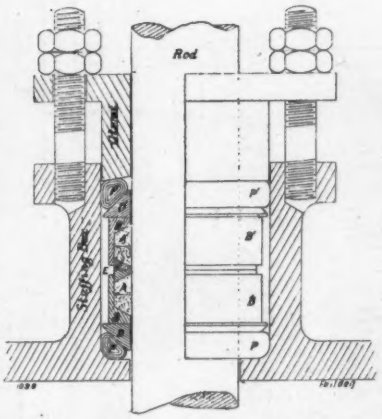
We also illustrate, on pages 543—545, the general arrangement of the machinery in the vessels, from which it will be seen that the three boilers are arranged in line with one stokehole forward, a screen bulkhead being fitted at the back of the boilers next the engine-room; the main steam pipes from each boiler to the engines are of solid drawn copper, a large right-angle bend being arranged in each for expansion. The throttle-valve chest is fitted with three branches, to which the main steam pipes are led. The auxiliary machinery is of the latest design, and comprises a pair of Weir's patent feed-pumps, with brass water ends and automatic control gear, one of Sir Christopher Furness, Westgarth & Co.'s improved "Cleveland" feed heaters, and one of their 30-ton "Cleveland" evaporators; also a large "Hocking" feed-water filter. The auxiliary machinery is worked by steam of full boiler pressure, and is arranged to exhaust either into the main condenser or to the waste steam pipe, which is carried up the side of the funnel. It will also be noticed that the forced draught fan, with its two engines, is conveniently placed in the engine-room.

The arrangement of the tank and bilge pipes throughout is as direct and simple as possible, the bilge pipes being entirely separate from the ballast pipes, so that there is no danger of flooding the bilges when the ballast tanks are being pumped up.

## SOME ENGINEERING SPECIALITIES.

MESSRS. BROWN AND CO., 49, Deansgate, Manchester, are introducing a couple of engineering specialities worth more than ordinary attention. The first of these, called a "Floating Metallic Packing," constitutes a considerable advance on engineering practice in the direction to which it applies. Its nature may be understood from the following short description.

It will be seen from the illustration that the floating metallic packing requires no alteration in existing packing boxes or glands. The packing consists essentially of two antifriction metal rings (*A* and *A* 1), which surround the piston rod, and which are formed of several sections to enable the wear to be taken up and to allow of the rings thus formed to be pressed firmly against the piston rod. These rings are held by cup-shaped bushings (*B* and *B* 1), and pressed in by washers. The bushings, as shown, are free to move laterally with the piston rod in any direction, and have a seating against the collars *D* and *D* 1




DETAILS OF MESSRS. BROWN AND CO.'S FLOATING METALLIC PACKING.

to prevent the leakage of steam passing against them. These collars again are held in turn against rings of ordinary soft packing, shown at *P* and *P* 1, which, pressing against the gland and the base of the stuffing box, prevent any steam leakage around the outside of the collars *D* and *D* 1. The soft rings, too, act as a cushion, so as to allow play in the direction or movement of the rod, acting, indeed, in a similar way to a universal joint both at the top and the base of the stuffing box.

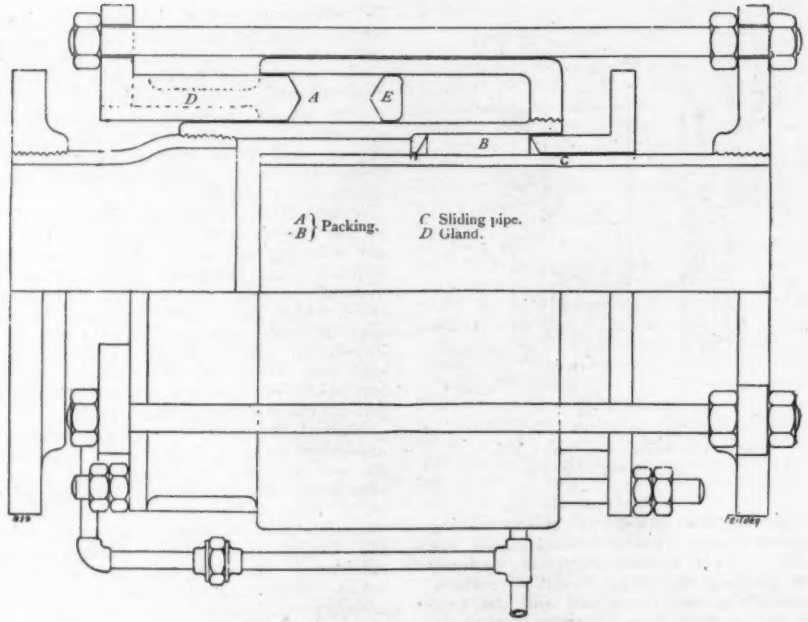
On the pressure being put on the packing by the ordinary studs and nuts of the gland, the action is as follows :—

Steam will attempt to pass along the surface of the rod through the end of the stuffing box, but is checked at the back of the ring *D* by the packing *P*. It cannot pass between the ring *D* and the cup-shaped bushing *B* because of the joint made between the two, whilst the antifriction metal rings *A* intercept and prevent its passing along the piston rod. Should any slight leakage take place past the first packing it only gets into the interior of the stuffing box marked *E*, and a small drain pipe can be connected where considered necessary to take away any condensed water. But no steam can pass further than the first packing, as it is met by the set of anti-friction metal rings *A*1, the bushing *B*1, and the soft packing ring *P*1, so that both steam and water are effectually held from following the rod.

It is evident that this packing is suitable for vertical as well as horizontal engines, whilst it may be stated that in the case of the steam hammers, which have previously given trouble, the packing acts perfectly. The "Floating Metallic Packing" is claimed to be simple, durable, and exceedingly economical, and efficient in the highest degree; and there appears no reason to doubt that these claims are amply substantiated in practice.

Messrs. Brown & Co. also direct attention to the forged steel expansion joint they are bringing out as a substitute for the ordinary cast expansion joint. This is avowedly a joint intended for high pressures, which have vastly increased in use since the cast-iron expansion joint was first introduced. In the forged steel joint, the shell and sliding part are made of forged steel, whilst stops are provided that effectually prevent the pipes being blown apart.

Messrs. Brown & Co.'s patent balanced expansion joint is intended to supersede the ordinary cast and forged steel expansion joints currently in use. The cast joint is of little utility with the high steam pressures now so largely employed, whilst the forged steel joint, although fairly efficient, is attended with material drawbacks. For instance, whilst the ordinary arrangement answers for comparatively short pipes, where an end pressure does no harm, should the pipe have bends or turns which allow of it being forced endwise, the sliding pipe of the joint may be forced hard against the stops, remaining in that position almost as if it were a fixture, when it becomes an expansion joint in name only, and may entail serious annoyance and cause enormous pressures upon the end walls of buildings. The balanced expansion joint, on the other hand, overcomes the whole of these disadvantages. It consists of an annular chamber, provided with a special packing box and piston, and the annular chamber surrounds the shell in which the sliding pipe works, the area of the annular piston being equal to that of the sliding pipe to which it is attached by means of the long bolts shown in the illustration. Connections are made between the sliding pipe and the chamber, so that the steam pressure is the same in both; and as the pressure tends to force the sliding pipe in one direction and the annular piston in the opposite one, the forces balance each other, and the pipe is therefore free to slide in or out of the expansion joint without regard to the pressure that may exist. The balanced expansion joint is made of steel forgings, with the exception of the glands, and the cost is little in excess of the ordinary joint,




MESSRS. BROWN AND CO.'S BALANCED EXPANSION JOINT.

and this is amply compensated for by the security attained through its use and the total absence of repairs and their attendant troubles.

## A NEW WOOD-WORKING MACHINE.

We have had lately the opportunity of inspecting a wood-working machine which appears to likely to effect an important influence in the wood-working industry. The "Diagonal and Universal Machine," as it is described in relation to wood working, is the invention of Mr. Messinesi (Consul-General for Greece), and represents the outcome of five years of continuous work and experiment.

By its means the untrained operator can produce, at the first attempt, a perfect joint at the precise angle he requires, without that risk of over- or under-treating his work which so often results in rendering the material useless for the object which he is constructing. The machine itself, as will be seen from the attached illustration, is of compact construction, while it is readily adaptable to a large number of different operations.

For instance, the "Diagonal and Universal Wood-Working Machine," apart from its capacity of producing perfect angular work, can be immediately utilised as a jack-saw, a boring, grooving, routing, slot, morticing or recessing machine; or for moulding, dovetailing, carving, tenoning, or turning. Altogether, its capacities are so various that it would appear that artistic craftmanship has met with one more powerful competitor, seeing that the work of hand, in this instance, is not merely imitated but improved on by mechanical means.

The chief accessories to the machine are the angle adjuster and projector, by whose application many important operations may be conveniently obtained. The production of correct angular joints is rendered a certainty by the employment of these adjuncts to the machine, when used with the angle-tables which have been worked out by the inventor. The angle adjuster, shown in the illustration on the next page, is represented as the basis of the infallible angle in the production of the joints at the proper angle, and its operation is thus

THE DIAGONAL AND UNIVERSAL WOOD-WORKING MACHINE, SHOWING THE ANGLE ADJUSTER.

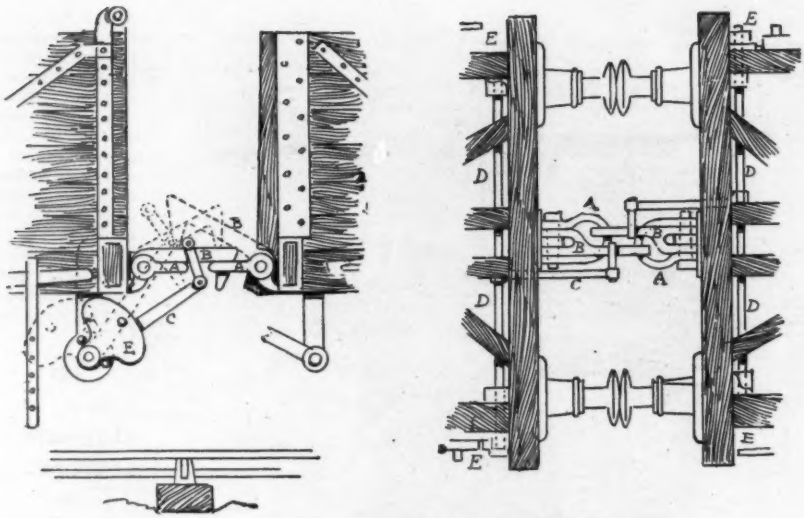
described. The adjuster is placed on to the protractor in a position specially prepared, so that the inner line of one of the bars rests on the zero, while the centre of the hinge finds the centre of the protractor; the second bar is then drawn out to the required degrees, and the bars are then fixed by screwing tight the bolt which slides in the slotted bar. The adjuster is then lifted from the protractor and placed on the machine, one bar flat against the saw, whilst against the other bar the hinge is brought flat and fixed in that position, and the machine thus becomes set at the required degrees.

The machine is stated to work at any angle between zero and 90 degrees, and it is claimed that the desired angle can be found at once.

## A NEW AUTOMATIC COUPLING.

THE introduction of the Parliamentary measure which is intended to secure the compulsory use of a system of automatic coupling for railway carriages and wagons has already been productive of a flock of miniature designs by inventors who, in many cases might have spared their labour by a slight reference to previous experience.

Automatic couplings have been worked out in the United States to an exhaustive extent, and we have, consequently, the accumulated experience of years to guide us if we care to profit by it. The great objection urged against the Bill now being promoted on behalf of the Board of Trade has been that its carrying out would involve structural alterations in existing railway plant to a degree that would seriously menace the financial position of




DETAILS OF MESSRS. THOMAS AND CO.'S NEW AUTOMATIC COUPLING.

the railway companies. A great deal of exaggeration may be assumed as a matter of course in such a contention; but, on the other hand, there is no doubt that this aspect of the question is one not to be cursorily dismissed in its consideration.

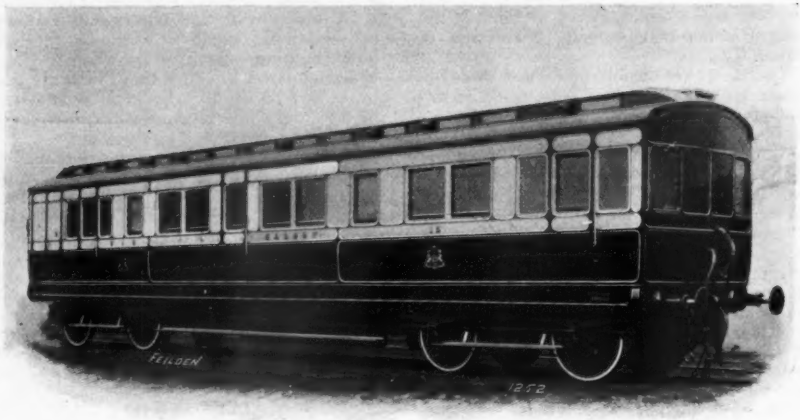
In the appliance we describe and illustrate there is no alteration required in existing plant, except the cutting off of the hook at the end of the draw-bar as now commonly in use. The invention is that of Mr. W. Thomas, of Messrs. Thomas & Co., coal contractors and ship-brokers, of Cardiff, and, as may be seen, is of a simple yet very efficient and inexpensive character. The nature of the coupling can be understood by a reference to the drawings. It consists of a loop (*A*) and a hook-bar (*B*), both of which are attached by a simple bolt to the end of the draw-bar, as at present in practice. Both of these are in duplicate, so that whichever end of the truck is presented there will always be a loop to face a corresponding coupling.

The end of the hook-bar being inclined at an angle of 45 degrees to the horizontal loop facing it, the hook slides up by the impact of a closing wagon to the front of the loop and, dropping into position, couples the wagons together without the possibility of a failure.

The coupling is effected by an arm (*C*) attached to a revolving bar (*D*) situated under the body of the wagon, and worked by weighted levers (*E*) at either end. These levers are placed under the buffers, and can be thrown over to the position indicated by the dotted lines in the drawing from the side of the train. When thrown over, the lever strikes a catch in a metal plate rigidly fixed to the end of the bar (*D*), causing it to make a rapid turn, raising the arm (*C*) which, by means of a pin attached to it at right angles, strikes *B* up into the position indicated in the drawing. There are two pins in the arm referred to, one above the hook-bar to keep it into position, the other, parallel with the first, but underneath the hook, striking it up when uncoupled as already described. The parts are so arranged that a certain amount of play is allowed for curves and deviations of buffers.

## THE LATEST IN RAILWAY FAMILY SALOONS.

THE Caledonian Railway Co. have just turned out from their St. Rollox workshops a new type of family saloon carriage, combining many new features, and which, as regards style of furnishing and decoration, as well as comfort and convenience-giving accessories, marks a decided step in advance




NEW FAMILY SALOON CARRIAGE, CALEDONIAN RAILWAY.

of anything hitherto seen in that part of the country.

The carriage measures 50 ft. 3 in. in length (exclusive of buffers), and is divided into a suite of six compartments—five for passengers and one for luggage.

At one end is a commodious coupé provided with four revolving chairs, and a collapsible table, which, when not in use, lies flush with the end of the vehicle. Being intended for smoking, there are spittoons sunk in the floor. Next to it are three compartments, each containing one couch and two single fixed seats with double arm rests, in addition to a collapsible table.

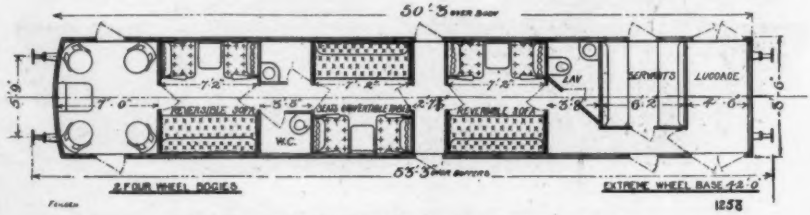
Forming the other end of the carriage is the space allotted for luggage, and to which access is gained directly from the corridor; while adjoining it is a compartment laid out in the ordinary manner, and intended for the use of servants.

The varieties of wood employed in the interior decorations are sycamore and walnut, relieved with gold mouldings and decorative panels. The upholstery is in figured moquette, embossed morocco leather, and trimming laces to match. The ceiling and frieze are of lincrusta, having a white groundwork with the relief designs picked out in gold.

The most obvious departure from usual practice, however, lies in the form of the roof, which is constructed on the clerestory principle, *i.e.* having a raised centre portion running from end to end of the coach, panelled in glass on either side, above the ordinary roof, thus adding materially to the breathing space and admission of daylight.

On this raised portion are placed a number of patent air-extracting ventilators, which are conveniently regulated by means of brass rods.

Of the other innovations introduced, mention may be made of the ingenious mechanical contrivance by which the couch in the three compartments so fitted is transformed, with the minimum of trouble, into a bed for night use; and likewise the ease with which




PLAN OF NEW FAMILY SALOON CARRIAGE, CALEDONIAN RAILWAY.

the collapsible tables found in four of the compartments may be put in and out of action.

The doors (of which there are three on either side of the saloon) are fitted with a new form of patent draught and dust excluder.

Ample provision has been made throughout in the matter of lavatory accommodation, as well as a plentiful supply of hat and coat racks, bevelled mirrors, and umbrella stands. The internal equipment also includes a complete installation of the most improved heating apparatus, which is actuated by steam from the locomotive, and this is supplemented by a gas-stove for domestic purposes, placed conveniently in a bend of the corridor, opposite a miniature water barrel of polished oak hooped in silveroid.

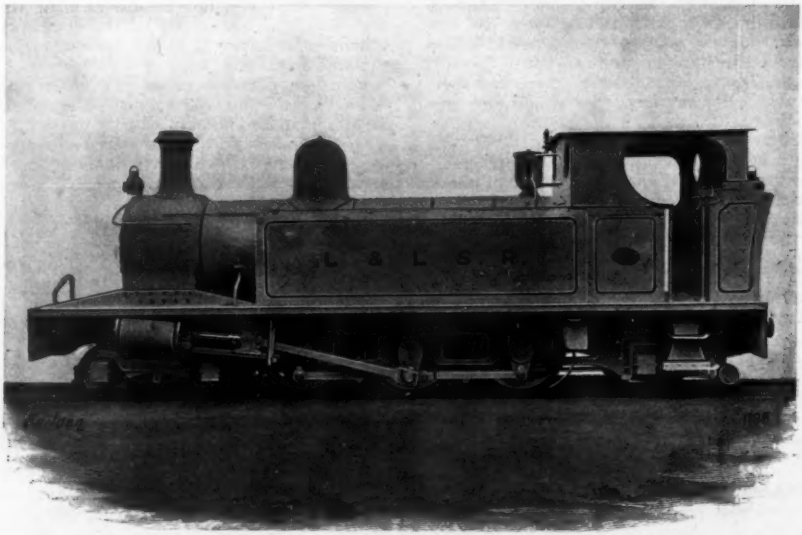
The artificial lighting is effected by electricity generated by a dynamo hung on the underframe of the vehicle, and driven by an endless leather-link belt revolving round the axle of one the wheel-bogies. Suspended from the roof of each compartment is a highly-ornamental 4-light electrolier, each light being 10-candle power, and throughout the passage there are single electric lamps.

By means of storage battery cells a reserve of electricity, equal to from six to eight hours' lighting capacity of the whole carriage, is accumulated in order that the lights may be turned on when the vehicle is at a state of rest, and while electricity is consequently not being generated.

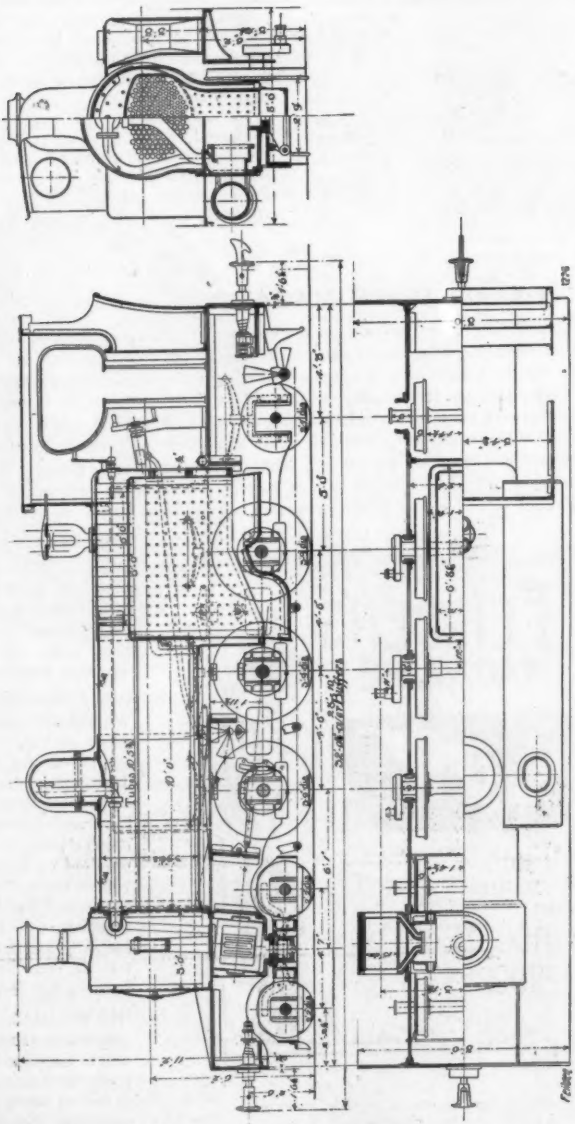
These travelling palaces—for they may be justly termed such—are peculiarly suited for rendering pleasant a protracted railway journey, not merely on the familiar Caledonian Railway, but over whatever number of British lines they may be required to travel by those fortunate enough to be able to charter them, and will no doubt be duly appreciated.

## A LARGE NARROW-GAUGE LOCOMOTIVE.

By the courtesy of Messrs. Hudswell, Clarke & Co., Ltd., we are enabled to give some illustrations and particulars of what is the largest narrow-gauge locomotive now running in Ireland. The locomotive we refer to was designed by Mr. F. T. Miller, the Resident Engineer to the London-



NARROW-GAUGE LOCOMOTIVE, BUILT BY MESSRS. HUDSWELL, CLARKE AND CO., TO THE DESIGNS OF MR. F. T. MILLER, FOR THE LONDONDERRY AND LOUGH SWILLY RAILWAY COMPANY.



DETAILS OF THE NEW NARROW-GAUGE LOCOMOTIVE, LONDONDERRY AND LOUGH SWILLY RAILWAY.

derry and Lough Swilly Railway Company. The chief dimensions are as follows :—

| | | ft. | in. |
|---|---|---|---|
| Cylinders (diameter) | ... ... | 0 | 15 |
| Stroke | ... ... ... | 0 | 22 |
| Wheels (diam.) Coupled | ... | 3 | 9 |
| Wheels (diam.) Bogies | ... | 2 | 2 |
| Wheels (diam.) Radial | ... | 2 | 6 |
| Wheel Base | ... ... ... | 22 | 4½ |
| Gauge | ... ... ... | 3 | 0 |
| Weight (loaded) | ... ... | 42 tons. | |

The boiler is intended to work at 150 pounds pressure per square inch. The wheel-centres, axle-boxes, and horn-blocks are of cast steel. The engine is fitted with a steam and automatic vacuum brake in addition to the usual hand-brake, and, as will be seen from the view we present, forms an admirable example of artistic locomotive engineering practice.

Two of these engines, supplied by Messrs. Hudswell, Clarke & Co., Ltd., have been working so satisfactorily during an extended period, that the firm have received an additional order for engines of the same type, which they are now engaged in executing.



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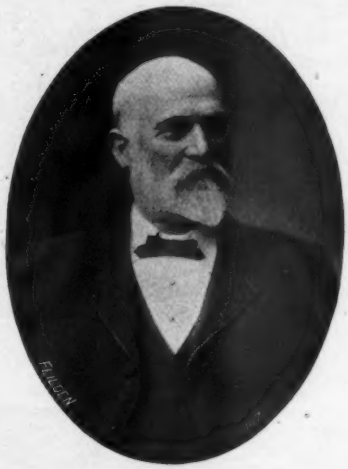
# THE COOLGARDIE GOLDFIELDS WATER SCHEME.



It has been left to colonial enterprise to invent, and put into practical shape on a large scale, what is probably one of the most efficient and, at the same time, the



MEPHAN FERGUSON, ESQ.

cheapest form of water-carrying pipe that has yet been devised. This is the "Ferguson" Patent Locking Bar Steel Pipe, of which 330 miles in length are now in progress of construction for the great Coolgardie Goldfields Water Scheme. Before coming to a description of the pipe itself, and the methods adopted in its construction, it may be interesting to briefly refer to the scheme as a whole, and to the route along which the pipes are to be laid. The line will extend from Perth (the capital of Western Australia) to Coolgardie, the centre of an important group of goldfields. After considerable opposition, and as is not unfrequently the case, from the very people which the scheme would chiefly benefit, the Colonial Government has succeeded in getting the scheme approved of by the legislature, and the same is now being carried out. It is estimated to cost 2½ millions sterling, but bearing in mind the fact that this covers the whole cost of the pipes, trenching and laying of same, pumping engines, dam making, etc., complete for a continuous supply of pure water to the extent of 5,000,000 gallons per 24 hours for a distance of 330 miles, it is an exceedingly low figure, and only possible on account of the cheapness of the Ferguson pipe. It is not unlikely that the amount of the whole contract may be exceeded, but even if it were the increased expenditure would be fully justified, when it is borne in mind that the monthly output of gold for the Colony has now reached something like 150,000 to 200,000 ozs. As is well known, a good supply of water is an essential factor in the most approved systems of gold extraction, and whilst this particular district is rich in the precious metal, it is unfortunately very deficient in water supply, and it has long been recognised that an adequate supply would immensely benefit the goldfields, and thereby the colony as a whole. The water will be collected in a large reservoir at Mundaring, which is about 24 miles from

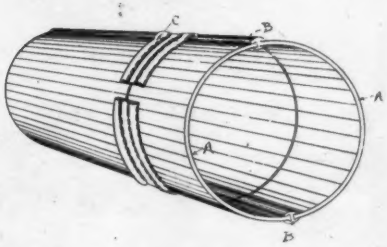



FIG. 1.—SHOWING TWO PIPES JOINTED TOGETHER.

PLATE JOINTS.

FIG. 2.—BEFORE CLOSING. FIG. 3.—AFTER CLOSING.

FIG. 4.—CROSS-SECTION OF THIMBLE.

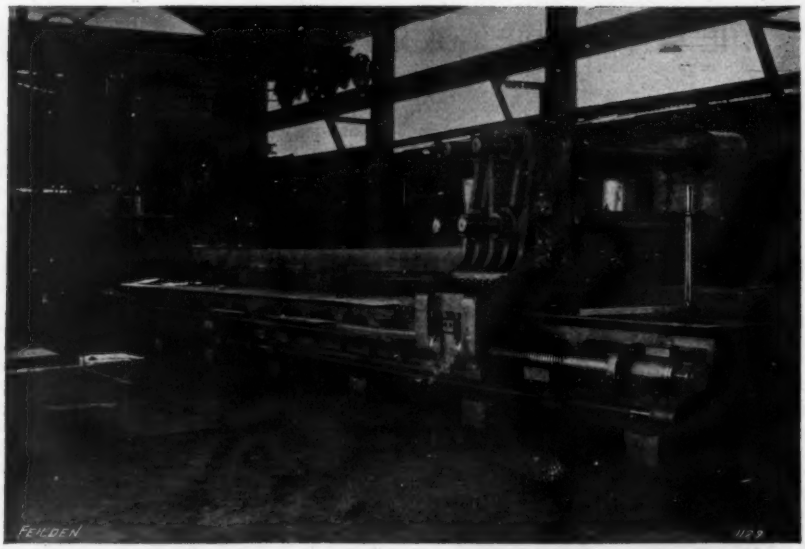



FIG. 5.—GENERAL VIEW OF SPECIAL PLANING AND UPSETTING MACHINE.

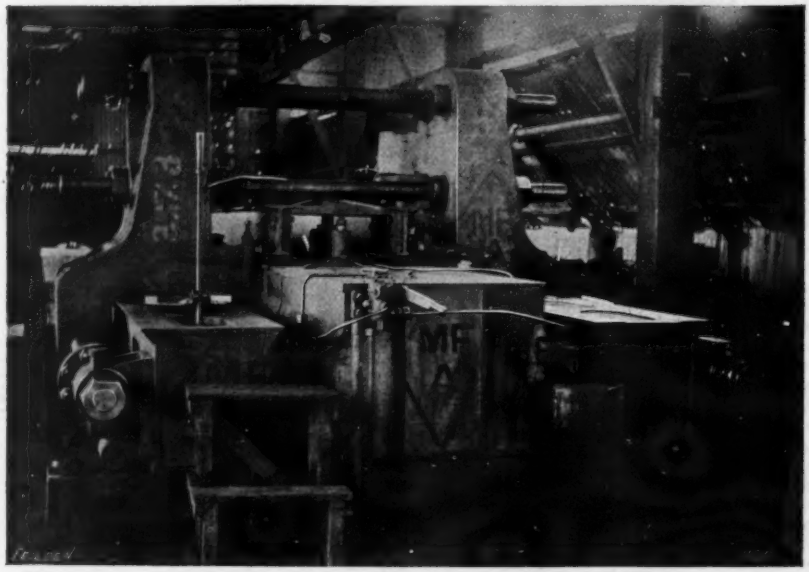


FIG. 6.—END VIEW OF SPECIAL PLANING AND UPSETTING MACHINE.

Perth (W. A.), and from whence it will be pumped from eight pumping stations situated at different levels on the route. The total height that the water has to be lifted is about 1,200 ft.; and the distance between Perth and Coolgardie, as already stated, is 330 miles. Of this distance 300 miles will be trenched to receive the pipes, whilst for the remaining distance of 30 miles the pipes will be carried on trestles across the salt lakes. Such is briefly the scheme, and it will be readily understood that it is not only a big and ambitious scheme, but that if carried out successfully, of which result there is every indication, it will redound with credit to one of the most enterprising and go-a-head of our colonies.

It may be stated that the Colonial Government, as represented by Sir John Forrest and other gentlemen, paid a visit in November last to the Falkirk Works to inspect the pipes being constructed for the Coolgardie Water Scheme. During the speeches Sir John Forrest paid a high tribute to the ingenuity and enterprise displayed by Mr. Ferguson. He also expressed a belief that in less than eighteen months they would have a powerful stream of fresh water running into Coolgardie, which, besides giving the people on the goldfields health and comfort, would bring undoubted success to the colony; and such a wish, it is almost needless to add, will secure a sympathetic echo in the mother country.

Mr. Mephan Ferguson, who is now on a visit to this country, has lived in Australia the greater part of his life. He was born in Scotland of Scotch parents, and left that country when only ten years of age. In 1875 he established an engineering business at North Melbourne, but owing to its rapid increase he was compelled to move to larger premises in Leicester Street, Carlton, known as the Carlton Foundry. The great advantages of steel pipes over cast-iron pipes for certain purposes having been fully demonstrated, and having secured large contracts for the former, he again extended his operations, and constructed larger and more commodious premises in West Melbourne, putting down at the same time an extensive hydraulic plant for the manufacture of steel pipes. At the present time he has works and offices at Melbourne, Footscray, Adelaide,

FIG. 7.—VIEW OF SPECIAL PLANER, SHOWING ONE OF THE SIDE CHEEKS AND TOOL HOLDERS.

FIG. 8.—CRIMPING MACHINE.

and Falkirk, near Perth, W.A., being also represented in London. The Falkirk pipe works are here illustrated. About three years ago Mr. Ferguson was forcibly struck with the advantages likely to accrue from a wrought-iron or steel plate pipe which should be free from rivets, and the consequent friction arising from them, especially where water had to be conveyed for long distances, but which should be at the same time light and strong, and, in fact, possessing all the advantages of a wrought-iron or steel pipe without the disadvantages already referred to. Such a pipe he devised, and it is much to his credit that within four months of its conception he had built a special plant capable of turning out large-sized pipes in quantity, and which has been adopted for the Coolgardie Water Scheme.

Referring now to Figs. 1, 2, 3, and 4, which are taken from a diagram, Fig. 1 shows a perspective view of a short length of the pipe, and from which it will be at once seen that each length of pipe consists of two wrought-iron or preferably steel plates, A and $A^1$, each bent to a complete half-circle, and having their edges thickened up as shown (the method of doing which will be fully described later on). In order to connect the two half-circles, their edges fit into two longitudinal locking bars, B and $B^1$, as shown in Fig. 2. By the application of hydraulic pressure the locking bars are caused to close over the thickened edges of the plates, as shown in Fig. 3, and thus form a double dovetail joint. With regard to the strength of this joint, it may be stated that elaborate and extensive tests have shown that the plates have always given out before the joints, even where the plates have stood as much as 29 tons per square inch before parting. Even under such a severe test as this the joint has remained intact, and the plate has not even drawn away from the locking bars. Referring again to the diagram, the part C (shown in sectional detail in Fig. 4) forms the joint for connecting the lengths of pipes together, and from which it will be seen that it consists simply of a wrought-steel thimble or ring with lead run in at both sides, and forming a wedge or dovetail joint against the egress of the water. This has been found to answer as perfectly as the longitudinal joints already described. Such

is a brief description of the pipe, which is extremely simple, and one can only express surprise that such a pipe had not been invented and practically made use of before this. It will at once be noticed that in the absence of rivets the interior presents a practically smooth surface to the water, and that, as there are no exposed edges of the plates, no caulking is necessary, and the danger of cutting the plates is avoided.

The size of pipes adopted in the Coolgardie scheme is 30 in. diameter, and these are made up in 28 ft. lengths, the steel plates being $\frac{1}{4}$ in. thick. The weight of each 28 ft. length, complete with its two steel longitudinal strips, which are known as locking bars, is about 24 cwt. It will be at once realised that the total weight of plates used in the scheme will be very considerable. This can readily be got at, since the plates, forming each 28 ft. length, weigh 22 cwt., and as there are 62,229 lengths in the 330 miles, and each length weighs 22 cwt., the total weight of the plates alone is close on 68,452 tons. To this, of course, must be added the weight of the thimbles and the longitudinal strips, in order to get at the total weight of the pipe portion of the contract.

The whole of the pipework is now under construction in Australia, and it will probably now prove interesting to follow the various stages of the process by which the pipes are made. For a 30-in. diameter pipe each plate has to be 3 ft. $11\frac{1}{4}$ in. wide, and they are 28 ft. long as already stated. The plates are first put through a set of straightening rolls, after which a template is placed on them, so as to get a centre line. They are then clamped to a table, which carries them through two pairs of circular shears—one pair at each end—so as to have all plates cut off to a dead length. From there they are taken to a planer and upsetting machine. This machine is shown in Figs. 5, 6 and 7, and is of very substantial construction, weighing over 100 tons. The bed, the section of which is shown most clearly in Fig. 6, is 50 ft. long. Upon the side beds slide the two massive side cheeks or saddles, which are connected together by heavy bolts, and which carry the tools for planing the edges of the plates, also the rollers for thickening or upsetting the same. In Figs. 5 and 7 are seen the powerful screws by which the side cheeks or tool-holders are caused to slide, whilst Fig. 6 shows the hydraulic clamping arrangement for holding the plate to the centre bed during the

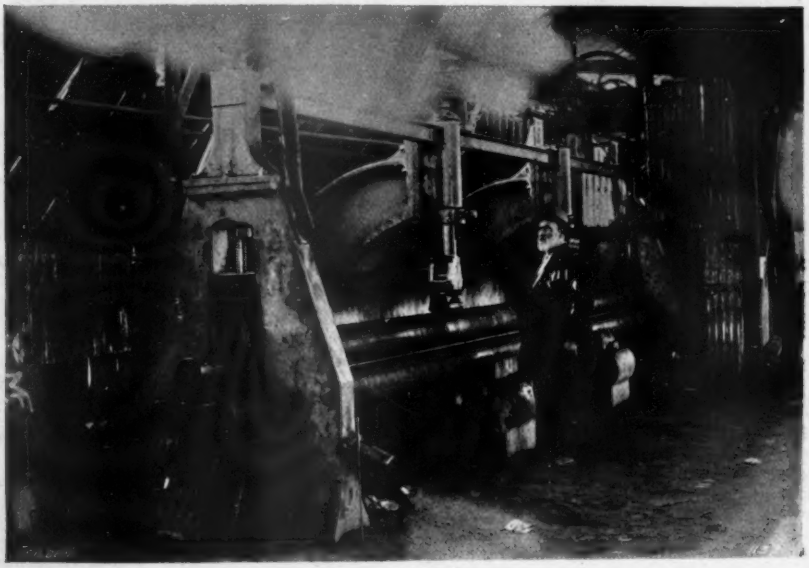


FIG. 9.—30-FT. BENDING ROLLS.

process of edge planing and upsetting. There are four planing tools on each side, each tool being set slightly in advance of its fellow. Again, there are eight rollers on each side, also set slightly in advance of each other. These press up against the edge of the plate, and the tool-holders slide along and thus thicken it into the form shown in Figs. 1, 2 and 3. The plate having been clamped down by means of the hydraulic clamps referred to above, and in such a way that the centre line marked on the plate coincides with the centre line of part of the plate. This massive planing machine embodies several interesting details in construction, and amongst these may be noted the method adopted for supporting the 6-in. leading screws to prevent them sagging. These screws are each 50 ft. long, and when supported at the ends only they were found to sag about 3 in. To obviate this and to secure a support, another screw is mounted below them and carrying supporting bearers as shown. This screw is cut to half the pitch of the leading screw, which carries two bearers placed

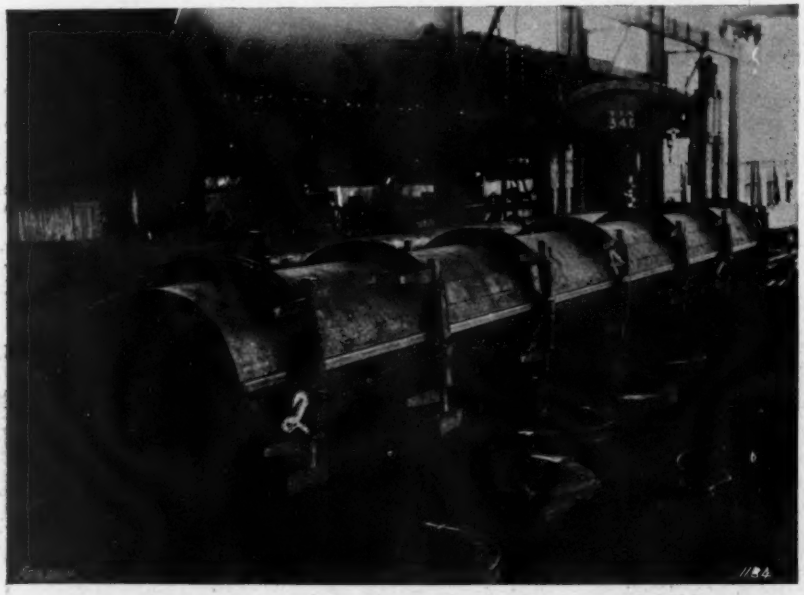


FIG. 10.—THE PARTS OF ONE 28-FT. LENGTH OF PIPE ASSEMBLED TOGETHER AND CLAMPED INTO POSITION READY FOR THE LOCKING BARS TO BE CLOSED UP.

machine, the same is set in motion, and planes and thickens both sides in one stroke. The plate is then removed to the next machine and another plate inserted, when it is then treated in a similar manner on the return stroke of the planer. It must be noted that in addition to the rollers used for thickening the edges of the plates, there are a pair of rollers (having their axes at right angles to the thickening rollers), shown most clearly in Fig. 6, and bolted to the sides of the cheeks. These are for the purpose of maintaining an even section of the thickened midway between the end of the screw and tool box on either side, so that when the machine is set in motion the tool box chases the bearer, but, seeing the bearer has only half the distance to go, both it and the tool box arrive at the end at the same time, whilst the other bearer is at the middle of the machine, thereby supporting the screw. After leaving the planing machine, the plate then passes to what is termed a crimping machine, shown in Fig. 8. The object of this machine is to put the necessary curve on the edges of the plate, since, as is well known,

a set of plate-bending rolls (which is the next machine brought into use) will not bend plates right up to the edge. This machine, which works by hydraulic power, simply squeezes both edges of the plate between suitable dies in order to commence the curve which the bending rolls complete. The pressing between these dies does not in any way disturb the thickened portion of the plate. Fig. 9 illustrates the set of bending rolls employed, showing a plate in them which has just been bent to a half-circle. These rolls are 30 ft. long, and in order to prevent them springing away from the plate or sagging, suitable supports are placed underneath the two bottom rolls, and also above the top roll, the adjustment of the top supports being regulated by gearing from above. The next illustration, Fig. 10, shows all the parts assembled together and clamped into position ready for the locking bars to be closed up. The hydraulic machine for doing this is shown in Fig. 11. This consists of a massive frame which carries the top and bottom tools, which press against the portions of the locking bars that come outside the pipes. To deal with the inside of the pipe, a long mandril (extending away to the back of the photograph) passes through the interior of the pipe. The mandril is provided with a hydraulic piston actuating an inclined plane at the tool end of the bar, which, when in action, has the effect of bringing all the tools home prior to the final squeezing action which closes the locking bar into the form shown in Figs. 1 and 3. It will readily be understood that both locking bars are squeezed together at the same time, and that the length of the portion squeezed up at each stroke of the machine is equal to the width of the tools used. It may be stated that the machine gives 20 strokes per minute. The pipe is then run on a crane to the cropping machine, when the protruding ends of the locking bars are cut off. It has next to be tested, and for this is rolled to the testing machine, and, having been placed in position, is filled with water, and subjected to the Government test of 400 lb. per square inch, which represents about 10 tons tensile strain per square inch on the metal. On passing the test the pipe is then taken to the drying machine, when it is subjected, by means of hot air, to a temperature of 300 degrees Fahr. before it goes into the coating bath. This is a tank containing a solution of Trinidad asphaltum, tar, &c., and kept boiling up to 400 degrees Fahr. when in use. It is heated by a furnace underneath fed, with coal. Two pipes are treated at a time and remain in the bath for 35 minutes, at the

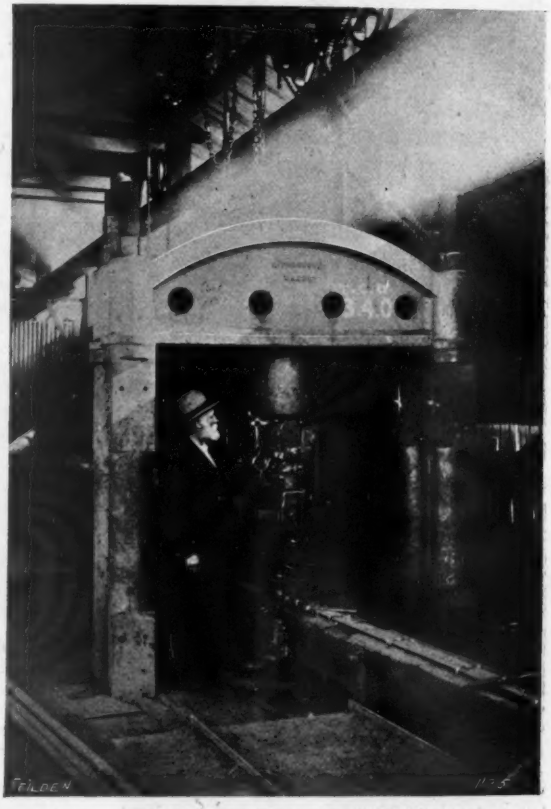
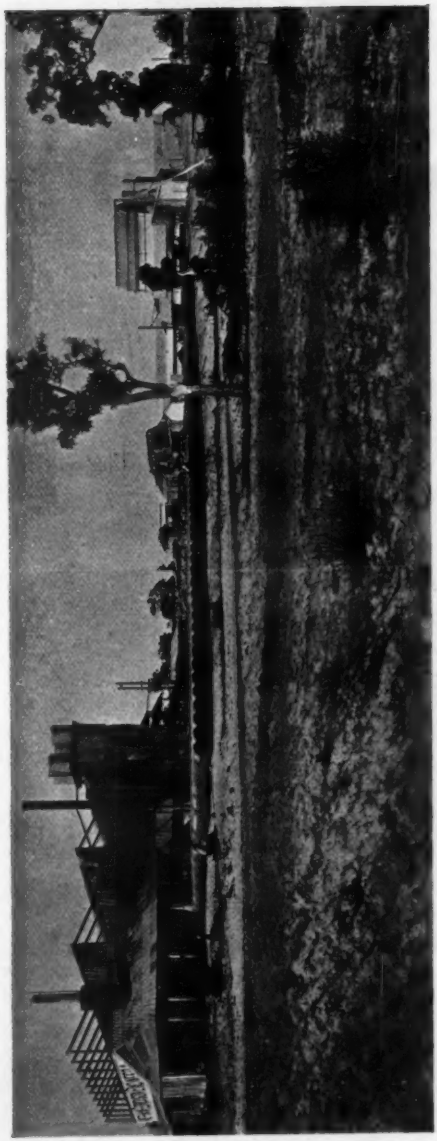


FIG. 11.—HYDRAULIC PRESS FOR CLOSING THE LOCKING BARS.



WORKS OF MR. MEPHAN FERGUSON AT FALKIRK, NEAR PERTH, WESTERN AUSTRALIA.

end of which time they emerge coated within and without. The pipe is then placed on a cooling machine, which somewhat resembles a large lathe, and upon which it revolves for about 20 minutes. During that time a cold blast of air is blown through the centre of the pipe to cool it, and also to give the coating a uniform thickness. While the pipe is revolving sand is thrown on the outside, the object, of course, being to prevent the pipes from sticking to each other, and also to save them from knocking about. This is the final part of the process, and the pipes are then removed to the ground beyond. One of the illustrations shows part of a 30-acre field covered with pipes for the Coolgardie Water Scheme at Mr. Ferguson's Falkirk Works. It may be interesting to note that the first plate was set up on August 4th last, and ten days later the first pipe was made, and that Mr. Ferguson is now able to turn out the pipes at the rate of one mile per day; but at this rate he would overtake the Government's present requirements, although very rapid progress in the laying of the pipes will shortly be made. At the present time only about 30 miles of pipe have been completed. As an instance of the rough handling which a Ferguson pipe will stand without affecting the locking bar, we give the following: A pipe, 7 ft. long by 2 ft. diameter by $\frac{1}{4}$ in. thick, has been twice dropped from a height of 10 ft., first on one side and then on the other, and without in any way injuring the joints. Again, pipes have frequently been dropped from the top of the railway truck on to two sleepers below without doing any damage whatever. A riveted pipe of similar sections would not stand such rough treatment with impunity, as the rivets and caulking would be sprung.

The locking-bar seam of the Ferguson pipe has been proved under actual official tests to be stronger than the tube plates themselves, consequently it is claimed that the Ferguson pipe is of even greater strength than a welded tube, while there is no danger of flaws due to faulty welds.

Pipes 28 ft. long and 30 in. in diameter are regularly turned out by

Ferguson's Patent Machinery at the rate of about 10 minutes for each pipe. By duplicating two out of a number of machines, double the quantity of pipes could be turned out in the same time.

The Ferguson pipe has been put to actual test and use by the South Australian Government, and from their experience, and from all the tests mentioned in their Government report, it would appear to possess some very material advantages over cast-iron riveted, or even a welded tube.

An important factor to the advantage of the Ferguson steel pipe is that it can be manufactured on the site of the pipe tracks, which means saving of carriage and freight for the bulky pipes.

From figures submitted to us, it would appear that though requiring less material, and less labour in manufacturing and in laying, the Ferguson pipe is cheaper and lighter, and at the same time stronger than any other pipe in use for the same class of work.

It may be stated that before the pipe was adopted for the Coolgardie Water Scheme, a strong commission, consisting of Professor Unwin and Messrs. Carruthers and Deacon, was appointed to investigate and report upon the whole scheme. This investigation also included very careful and exhaustive tests of the Ferguson pipe, and out of all of which it emerged very successfully. It must not be forgotten that it is largely due to the energy and enterprise displayed by C. Y. O'Connor, Esq., C.E., C.M.G., Engineer-in-Chief to the West Australian Government, and also T. G. Hodgson, Esq., C.E., Resident Engineer, who is supervising the contract, that the scheme has been launched.

Previous to its adoption for the Coolgardie Scheme the pipe had been subjected to a number of severe tests made on behalf of the South Australian Government, and had been accepted by it for various contracts. The introduction of the pipe, therefore, is due to the intelligent appreciation of its value displayed by A. B. Moncrieff, Esq., C.E., Engineer-in-Chief to the South Australian Government, also to Chas. A. Bayer, Esq., C.E., Sanitary Engineer, on whose recommendation the pipe was adopted.

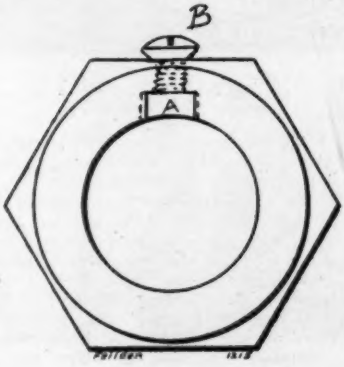
PIPES, COVERING A 30-ACRE FIELD, WAITING DELIVERY.

# WORKSHOP PRACTICE

**The purport of this section of FEILDEN'S MAGAZINE is to give the skilled mechanic in our great industrial establishments an opportunity of bringing his practical ideas and experience into print. Inventive capacity and careful thought on the part of the workman is what we desire to encourage and foster. To this end we invite skilled mechanics, foremen, under-foremen, and heads of departments, to communicate practical suggestions, which if accepted will be suitably paid for. Wherever possible, drawings should accompany the contribution; rough sketches will suffice, as, when draughtsmanship is at fault, we will do all that is necessary to render them fit for reproduction. Nothing will be too poor for a careful inspection. It will be seen that those contributions which appear in this section show distinct merit, and are both interesting and instructive.**

❀ ❀ ❀

**Troublesome Nuts.**—A frequent source of annoyance in many quick-running machine tools is the working loose of important nuts, through the increased speeds now in use causing a constant vibration. In many cases machine-tool makers prevent this difficulty by adopting one of the various locking devices now on the market; still, when an ordinary nut begins to slack back, the chances are, that unless it be attended to properly, constant trouble arises. A good method of preventing such annoyance where the bolt is not of sufficient length to allow of a locknut or split pin, is shown on the accompanying sketch. Remove the nut and carefully fit a steel key *A* which should be made a driving fit, by slightly tapering as shown by dotted lines; this will keep the key in place. Then remove the key and drill hole for screw *B;* now put key in position and retap the nut, after which fix on your machine, and no further trouble will be experienced.




TROUBLESOME NUTS.

**Long-Twist Drills.**—It frequently happens that a long drill-bit is required for special work, and such drills, in the majority of cases, are much better if they are of the "twist" type. The writer has had to use long drills for many years, and the method of utilising twist drills will doubtless be of interest to many who at present are making a shift with ordinary flat drills.

One way of doing this is as follows: A length of turned steel or iron, the same diameter as the drill, is screwed at one end. A brass ferrule is then screwed to this, and an ordinary twist drill, after being well nicked with a saw-file—to cause the solder to "bite"—is soft soldered into the other end of the ferrule (see Fig. 1).

The method just described will be found useful for many purposes, but for drilling deeply into the solid it will hardly be found satisfactory. A better method, and one usually adopted by the writer, will now be described. We will suppose that a $\frac{3}{4}$-in. drill is required. Procure a rod of best tool steel the requisite length, and of sufficient diameter to allow for turning up. Run it in the lathe, and turn about 2 in. to the exact size required, and the rest of the steel about $\frac{1}{16}$-in. less in diameter. Before cutting the twisted flute in the drill a guide must be made. Cut a piece of sheet brass to the shape of Fig. 2, 2 in. by 1 in., and bend it round the steel, keeping the edges square. The dotted lines will explain this. There will then be a space between the two edges of the brass, the same shape as the required twist. The drill can now be cut, first with a $\frac{3}{4}$-in. square file, then with a $\frac{1}{2}$-in. rat tail, and finished up with emery cloth wrapped round the file. The edge of the drill must be reduced a little to give it the necessary clearance, and the point shape as that of an ordinary twist drill. The hardening will be best done in oil. Drills made as here described will last for many months, as they can be ground down till scarcely any of the drill proper remains. Fig. 3 shows the drill finished.

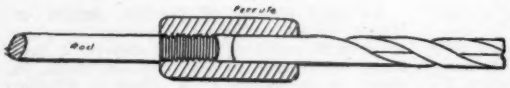



FIG. 1.

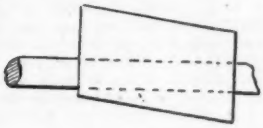


FIG. 2.

FIG. 3.

LONG-TWIST DRILLS.

**Repairs to a Lathe Headstock.**—In a modern machine shop, workmen for the most part are called upon to be efficient at some particular job, or to work some machine to its fullest capacity. In such a shop breakdown matters would be handled by others, who would probably replace a damaged piece by a new one direct from the stores. Many shops, however, still exist, where, if the tail screw of a lathe head should be turned up forcibly enough to snap the cast-iron bracket, as shown in Fig. 1, the foreman would be expected to get the lathe repaired with the least possible expenditure and as quickly as possible. The usual, if not invariable course is to get the blacksmith to forge a curved strap, which can be used to hold the broken parts in position. This kind of repair is common enough, and would enable the lathe to wobble along at a rough job, but it is evident that end pressure on the spindle would tend to open out the bend, as the strap is in the worst position for resisting this pressure. If an upper bolt be carried through the bracket and tapped into the casting or die, as shown, direct resistance would be given to the tail pin. A new danger would then present itself; for the hole drilled in the bracket would so weaken it that in all probability it would again break off at that spot. The lathe is assumed to be fitted with split dies for mandril bearings, so no room would be left for attachments on each side of the mandril itself. A more satisfactory form of repair can be made as shown by Fig. 2, so far as strength and durability are concerned, and if carefully proportioned it will not be unsightly. In this arrangement (Fig. 2) no attempt is made to use the old tail-pin boss; but, instead of this, a piece of wrought

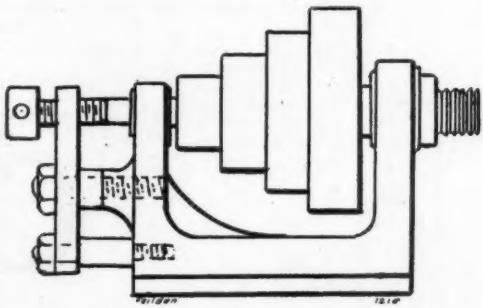


FIG. 2.

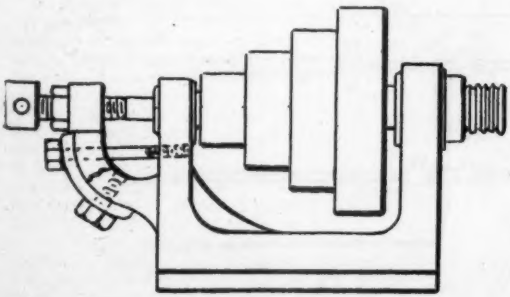


FIG. 1.

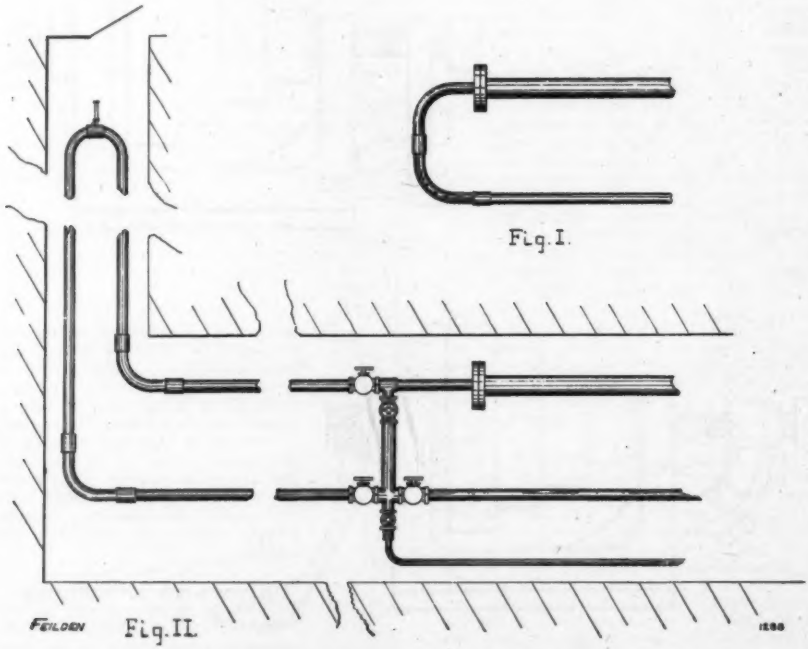
REPAIRS TO A LATHE HEADSTOCK.

iron or mild steel is used, having two clearing holes drilled in it for the lower bolts, and the upper hole tapped to receive the old tail-screw. The fractured elbow is cut away to form a square face, which is drilled and tapped for the centre stud. The casting is drilled and tapped for the lower stud and the job is complete. A cheaper job would result if two plain bolts were used, with gas-pipe distance pieces between the plate and the casting.

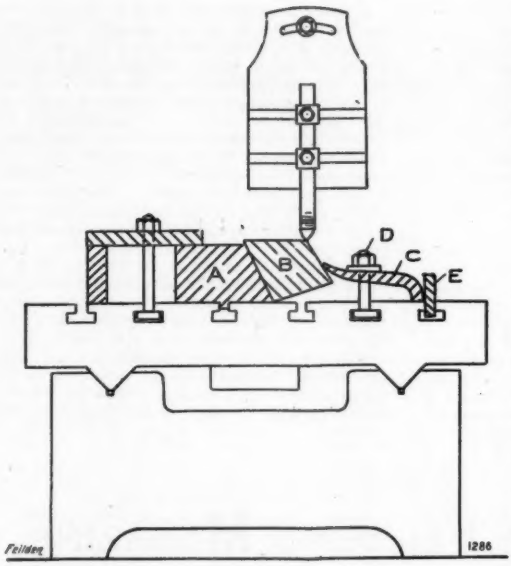
**Improvements in Ventilation.**—In a large building heated on the "Plenum" system considerable difficulty was experienced in heating some of the upper rooms satisfactorily. To

remedy this the arrangement shown in Fig. 2 was fitted and found to answer the purpose. In this system of heating and ventilating, the outer air after being filtered through a wet screen was drawn over a bank of steam-heated radiators, and delivered through passages and flues to the various rooms by means of fans. Fig. 1 shows the original arrangement of piping in passages leading to the rooms in question, to act as an auxiliary to the radiators, but it was found to be insufficient when the outside temperature was below 45 deg. F. Pipes were therefore added as shown by Fig. 2, the wrought-iron piping was carried 20 ft. along passage from cast-iron flanged steam pipe, and then 40 ft. up the vertical flue leading to the insufficiently heated rooms, an air valve being fitted at the top as shown. This effected an increase of about 10 deg. F. over temperatures previously obtained in the rooms. Valves were fitted, so that in warm weather the old arrangement might be reverted to and for convenience in case of repairs. The small pipe gave a plentiful supply of distilled water, a commodity much in request for chemical purposes and for replenishing a secondary battery. By means of the valves it will be seen that distilled water could be obtained, or, if not wanted, the water might be allowed to return to the boiler by the ordinary return pipe.

**An easy Method of Planing Angles or Wedge Pieces.** — Having frequently to plane strips with angles of various degrees, I have found it advisable to have cast-iron blocks, as shown in the sketch at *A* planed to different angles to suit the angle of any and all jobs of the kind that come to hand. In order to plane the new work, you fix the block or jig *A* firmly to the bed of the machine, and then the work *B* is placed against it, as shown in sketch, with the angle side to be planed at the top. The holding-down plate *C* shown is made specially for this class of work, and is the best for the purpose, as a straight plate would lie at a considerable angle to the bolt, and when screwed down tightly is likely to bend or break the same. The clip *C* is turned over at the back end and so forms its own packing. A stop *E* is placed at the end of the clip *C* to keep it from slipping off the work as you tighten down the bolt *D*. By this simple means the tool-box remains the same as for ordinary surfacing work, and no side tool is required. If you require to take the work off the machine a number of times you can safely rely upon it coming back into same position as before, and if, as sometimes happens, a dozen or two strips of exactly the same angle and size are required, this method is an excellent one if properly carried out. Whenever




IMPROVEMENTS IN VENTILATION.




METHOD OF PLANING ANGLES OR WEDGE PIECES.

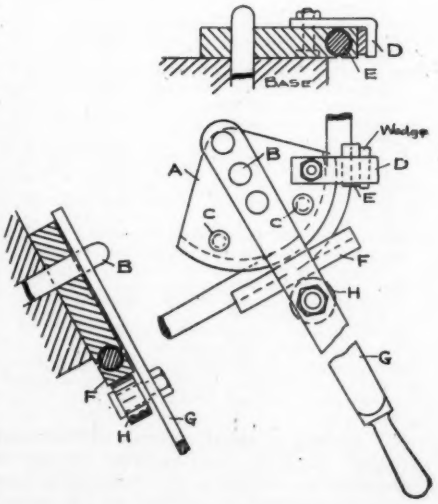
I have a quantity to plane so as to be interchangeable, I always rough them all down to within a light finishing cut, and do one right out and offer it into its place, and if correct, run the same cut over all the rest that are to be done, and by this means you can rely on an accurate size in each article. If, as sometimes happens, I have a few to plane with different angles to any of my blocks, I get the first one right, and then use it as a jig for the rest. S. W.

**A Simple Device for Bending Brass and Copper Pipes.**—A "former," *A*, of iron for small bends, or of wood for large, is turned to the required radius, with the edge grooved to suit the diameter of the pipe. A stout pin *B* is driven into a hole at the centre of curvature, and two countersunk headed bolts *C C* secure the "former" *A* to a suitable base such as an angle bending slab. The pipe is filled with resin or lead (usually the former) previous to bending and is held against the "former" *A* by a wooden wedge driven between a clip *D* and an iron guard-piece *E*, which is grooved to suit the diameter of the pipe so as not to dent it. A second longer guard-piece *F* is placed next to the portion of the pipe to be bent, and the lever *G* being slipped over its fulcrum, the pin *B* is pulled round, thus causing the roller *H* (which is free to revolve on a stout pin fixed to the lever) to travel along the back of the guard-piece *E*, and forcing the pipe round the "former" *A* without any unseemly dents or marks of any kind. If it is desired to carry the bend further round, the guard-piece *F* is slipped along the pipe and the lever pulled a further distance as required. Unskilled workmen have used this method and have produced excellent work, correctly and uniformly finished, up to 2½-in. diameter copper pipes. Two formers of different radii to each size of pipe used meet the usual requirements.

W. W. (Charlton).

**Notes on Hardening and Tempering Steel Tools.**—An efficiently equipped tool room, having up-to-date machinery and skilled mechanics for making tools of precision, is an expensive but indispensable adjunct to a modern manufactory, yet its efficiency is often endangered by a want of success in hardening and tempering its products.

Very frequently valuable milling cutters, forming tools, taps, rymers, etc., are ruined by injudicious treatment. The final process is too often entrusted to workmen who know nothing about the qualities of the steel used, and either ruin it by getting it too hot or by heating it unevenly alter the shape. This causes the tool to warp or bend, and by cooling




DEVICE FOR BENDING BRASS OR COPPER PIPES

when unequally heated, makes it harder in some parts than in others.

If the same care and skill used in making the tool were bestowed upon its hardening and tempering, better results would follow, whilst the life of the tool would be prolonged, and the cost of its making repaid many times over. What is the cause of the frequent failures and fractures which occur in attempting to harden and temper a given tool successfully? Absolute freedom from fracture is hardly obtainable since the causes which produce it are so varied. In some instances they may be traced to the use of unsuitable steel, it being not an uncommon thing to suppose that a cheap and low-grade steel will answer the purpose, and is often the real secret of failure. By careful treatment, however, the risk of fracture may be reduced very greatly. The first consideration is to provide a suitable fire. Avoid a fresh or green coal fire, and see that it is clear; this is absolutely necessary. The article should then be heated slowly and evenly to a cherry red, and if it be a milling cutter with cutting edge of a thin section cool it out in oil, using whale oil preferably.

If the cutter be over ¼ in. thick it will be best to dip it in water first, but only partially cooling it; then put it in oil to cool out completely. The partial cooling in water will harden the cutting edge only, and the final cooling in oil will toughen it, and in cutters or tools of thin section will often obviate the necessity of tempering. To decide this, the usual way is to try the temper with a fine-cut saw file on the back part of cutting edges, and if the file will not bite on it, then it is too hard and must be tempered. The final cooling in oil will often prevent cracking and fractures. It is the experience of the writer that failures rarely occur if oil be used as stated. Tempering may be done in various ways. The hot-plate is the usual method employed and is the readiest where only small quantities are tempered, but if the centre or boss of a cutter be much thicker than the outer edge the safest way is to heat a bar of round iron and put it in the hole of cutter, thus drawing the temper from the centre outwards. Other methods of tempering suitable for dealing with large quantities will be described in another article.

CALOR.

# The Scope of FEILDEN'S MAGAZINE.

**The following are some of the more important subjects that have been dealt with in the pages of "Feilden's Magazine."**

The Engineering Conference, 1899. Sir W. H. Preece, K.C.B., F.R.S.

Recent Characteristics of British Locomotive Engineering. C. Rous-Marten.

Acetylene Generators. Prof. Vivian B. Lewes, F.I.C., etc.

The Iron Making Blast Furnace as an Ideal Gas Producer. Horace Allen.

An Electrolytic Process for the Manufacture of Parabolic Reflectors. Sherard Cowper-Coles, M.I.M.E., etc.

Copper Steam Pipes. W. Edward Storey.

On the Nature of the Fracture of Armour Plates. Sir W. Roberts-Austen, K.C.B., etc.

The Construction and Equipment of an Up-to-Date Engineering Works. T. Scott King, M.I.M.E.

Piston and Ram Pumps. Philip R. Björling.

A Revolutionizing Innovation in the Glass Industry. Ludwig Grote.

Engineering in Britain and America. Tom Mann.

Governors; or, Control and Steadiness in Machinery. Prof. Robert H. Smith.

Indigo (the story of a threatened industry). Lionel G. Radcliffe, Assistant Lecturer, etc., Municipal Technical School, Manchester.

Modern Telephony. A. R. Bennett, M.I.M.E.

The Position in China. J. Grant Birch.

The Education Bogey. Sir Edmund Hope Verney, Bart.

A Revolutionary Invention in Weaving. Prof. Robert Beaumont, M.I.MECH.E.

Some Recent Experience with Steam Vehicles. John I. Thornycroft, F.R.S., M.I.C.E., etc.

What Western Civilisation and Machinery mean to China. Hiram S. Maxim.

Development of China and British-Chinese Trade. Geo. A. Goodwin, Whitworth Sch., M.I.C.E.

A Foreign Invasion. Geo. F. Bird.

Acetylene for Motive Power. Fredk. Grover, A.M.I.C.E., M.I.M.E.

The Bacterial Treatment of Sewage. Samuel Rideal, D.SC. LOND., F.I.C.

Arbitration in Labour Disputes. George Howell, F.S.S.

The Electric Tramway and its Future. James Swinburne M.I.C.E., M.I.MECH.E., M.I.E.E.

Feed-Water Heaters. George Halliday, Whitworth Scholar.

The Making of a Glow Lamp. C. J. Robertson, A.M.I.E.E

The Balloon as a War Machine. H. Lawrence Swinburne.

The Depreciation of Machinery. Prof. Robert H. Smith.

Compound and Four-Cylinder Locomotives in England and France. Chas. Rous-Marten.

Carburetted Water Gas. S. Cutler, Junr., M.I.MECH.E.

Machine Tools. } Ewart C. Amos, M.I.M.E.
Pneumatic Tools. }

The Building of a Great Railway. The most complete and interesting record of the Great Central Extension to London.

**Leading technical experts and commercial men of world-wide reputation have been retained—many at great expense—to contribute special articles of profound interest and paramount importance to the forthcoming issues. A mass of other interesting and valuable copyright matter, not published by any other industrial publication in the world, will also be presented.**

# INDUSTRIAL PROGRESS

ENGINEERING NOTES AND COMMERCIAL INFORMATION

FROM ALL SOURCES.

## ELECTRICAL ENGINEERING.

**Electric Locomotives for Railways.**—In a recent lecture Mr. Tischbein, engineer in the employ of the General Electricity Company in Berlin, discussed the advantages to be obtained from the use of electrical engines in place of steam engines, on railways. He introduced his remarks by reminding his hearers of the success of electric tramways, which augured well for the use of electricity on railroads. The conditions of these latter, however, he said, differed greatly from those of the former. This was owing to the circumstance that an essential part of the task of the railroads was the forwarding of goods. The heterogeneousness of the vehicles used for this purpose, and their essentially limited control, made it appear impracticable to think of a universal introduction of motor carriages for the transport of goods. The result of this was that it was necessary to fall back upon a means of locomotion on the railways corresponding to the steam locomotive– namely, the locomotive driven by electricity. Electric locomotives could be divided into two divisions—those for normal and those for narrow gauges. Then again they could be subdivided into such as were driven by a stream produced by wires running along the whole line, and those possessing accumulators, and those with mixed motive power. It seemed as though these latter would be especially used for normal gauges. For continuous traffic on ordinary gauges the electric carriages would be, according to Herr Tischbein, driven by means of overhead wires for longer or shorter distances. When the locomotive had chiefly shunting work to perform, and had to be continually moving on to different lines, then, in order to increase the motive power and facilitate the arrangement of the overhead wire system, accumulators would have to be used as well as the overhead wires. Again, if the traffic on the line was small, and the line itself a long one, and if an electric supply centre was present, or at least natural force available for the driving of the generator for the current, an accumulator locomotive would be chosen. The lecturer closed by comparing the economics of steam locomotives with those of electrical locomotives, which were greatly in favour of the latter. First in favour of the latter was the saving in the making of the machine and in the making and keeping in repair of the overhead structure of the line. This saving in itself outweighed the cost of the electric overhead wires. Then, again, it must be remembered that only one man was required to drive the electrical locomotive, and there was, besides, no need for the building of water stations, pumps, ashpits, and water tanks. Finally, he declared that electrical locomotion was more economical, in that it worked more continuously than steam locomotion.

**Electricity as Motive Power on the Berlin Metropolitan Railway.**—The "Union Elektricitäts Gesellschaft" has recently submitted to the German Minister of Public Works a project for the establishment of electric traction on the Metropolitan and on the Circular Railway of Berlin, where the use of steam-power is no longer adapted to meet the ever-increasing traffic. The trains on these railways, running on a single line—double lines being too expensive—and with frequent stoppages, succeed each other at an interval of two minutes, but a high rate of speed cannot be attained without danger, so long as steam-engines are used; while the use of electricity would make a far greater speed possible with full security to the travelling public. The Union Company in its memorandum shows that with an electric railway a speed of 0·5 km. per second can easily be attained, and while the greatest speed by steam hardly reaches 0·15 km., an electric train could run 80·1 km. (50 miles) an hour. The change of these steam railways, moreover, into electric railways would not require great modifications. The project provides for trains composed of eight four-wheel carriages, instead of nine, plus the locomotive, as heretofore; and it is estimated that, including the necessary stoppages, a speed of 50 km. (e. 31 miles) per hour could be maintained, which would be a saving of 17 minutes per hour on the Metropolitan and 15 minutes per hour on the Circular Railway. Each vehicle is to be furnished with two motors giving an aggregate of 350 h.-p., so that the eight carriages would represent 2,800 h.-p., as compared with 400 h.-p. by the steam locomotives. The energy will be supplied by two central stations, one at Charlottenburg, the other at Straulan-Rummelsberg, and carried to the motors by means of a third rail. To provide for emergencies, a battery of accumulators will be placed at each of the stations, and these batteries will be of a size large enough to ensure sufficient current for the journey, even if the generators at both central

stations should fail to produce energy at the same time. The estimated cost for this enterprise is about 43,000,000 marks (e. £2,150,000) minus the sum which the existing rolling stock would produce by sale, *i.e.* about £500,000.

**Vienna Electric Scheme.**—At a meeting of the Vienna municipal authorities held recently it was decided to place with the Schuckert Company of Nuremberg the contracts for the erection of electrical generating stations required for the Vienna electric light and traction schemes. It is proposed at present to instal eight generating sets with an output of 3,000 h.p. each, of which 15,000 h.p. will be used for tramway purposes. The estimated value of the contracts is over £1,250,000.

## CHEMICAL.

**The Spontaneous Combustion of Coal.**—A recent issue of the *Zeitschrift für Angewandte Chemie* there is an interesting contribution by Mr. R. Grimm, throwing a direct light on the phenomenon of spontaneous combustion of coal and its causes. A quantity of coarse furnace refuse and flue dust, containing a considerable percentage of unburnt coal, was exposed for some time to the weather. The action of air and water, aided by additions of hot refuse, produced ignition of the heap, which assumed the appearance of a diminutive volcano. The surface opened in fissures 2 in. wide, in the lower parts of which could be observed beautifully-shaped crystals of sulphur and an incrustation of sal-ammoniac upwards of ½ in. thick. Steam issued from the fissures, and sulphur and sal-ammoniac were deposited around them. The sulphur appeared in monoclinic crystals, having a length of ⅓ in. Ferric chloride seemed to be absent in the sublimated products. The deposition of such products from the nitrogen and the sulphur of coal has been observed on other occasions, but such perfect crystals have rarely, if ever, been seen. Mr. Grimm gives the following formula to explain the separation of sulphur from the mass:—

$$Fe\,S + H_2O = H_2S + Fe\,O.$$
$$2\,H_2S + S\,O_2 \text{ (arising from } Fe\,S_2) = 3S + 2\,H_2O.$$

**A New Use for Calcium Carbide.**—The experimental applications of calcium carbide seem to be steadily increasing in number. M. Charles de la Roche has successfully employed this product for the purpose of refining oil. The oil, according to his method, is stirred with about 10 per cent. of powdered carbide until the generation of acetylene has ceased. The lime which during this process is rendered free re-acts, and a greenish emulsion is produced. From this the oil can afterwards be drawn by a syphon, or be obtained clear by passing it through a filter. It will be obtained in this way almost colourless and free of acid and water. The advantage of the complete neutralisation by the lime would be unmistakable, were it not for the fact that the sulphate of calcium requires a long time to settle or to crystallize.

**Violet Scent.**—One of the most interesting products of the chemist's ingenuity—the artificial violet scent that has reduced the price of sweet violets considerably, and caused them to be sold at all seasons, *i.e.* ionon—is the cause of a very complicated patent litigation. Haarmann and Reimer, of Holzminden, Germany, claim to be the inventors; and they have brought an action for patent infringement against F. Fritzche & Co., of Hamburg, and have so far been successful in their own country as well as Great Britain. Since, however, a chemical product cannot be patented, and the patents can protect only a method of manufacturing, protection may ultimately fail when the product can be obtained by some other means, or when a similar method results in the production of another substance of different technical application. The difficulty in establishing the identity of method, and of certain chemical products, has been shown clearly during the recent law-suits. The true merit of the invention of ionon belongs to the celebrated German chemist, Tieman, recently deceased. In the year 1888, some chemists succeeded in isolating from backhausia an etheric oil, being characterised by a strong lemon scent, which therefore was called citral. Three years later Semmler demonstrated the identity of citral with an aldehyde, previously discovered and named by him geraniol. Citral may be obtained in various ways, and from it Tieman and Krüger derived a ketone, possessing a stale violet odour, which they named pseudo-ionon. By intermolecular change from pseudo-ionon, true ionon is developed which possesses the real sweet violet odour. There are, however, it appears, probably three isomeric ketones having this scent. One of these they isolated from iris roots, and they gave to it the name of irone; but in a subsequent experiment they obtained ionon. At the same time, Haarmann and Reimer, in conjunction with de Laire, had been working on a larger scale, starting from a decomposition of citral, and employing a method by which they obtained ionon, and which they patented. Afterwards Fritzsche manufactured an artificial oil of violets, which he placed upon the market as his invention, and the result has been the patent litigation, which is not yet concluded, and, owing to the difficulty of demonstrating the identity of the products and the methods employed for their production, may drag on for a considerable time yet, so that both claimants and defendants may have to sacrifice much money ere the issue—if ever—is reached.

**Tungsten.**—Professor Stavenhagen, of Berlin, has been studying the properties of tungsten, obtained for the first time in pure form by the reduction of the oxide by aluminium. He describes the metal as hard, slightly darker than zinc, and as being infusible in the electric arc. It is practically insoluble in acids, even in *aqua regia*,

although it is dissolved slowly in caustic potash. Tungsten, one of the rare metals, possesses considerable practical interest on account of the hardness that it imparts to steel.

**Partinium.**—An aluminium-tungsten alloy—in which the percentage of tungsten can be but small, since it is described as being almost as light as aluminium, and of varying composition—known as partinium finds considerable application in France in the construction of automobiles. The specific gravity is quoted as high as 3·1. Such alloys have been known for some time, and there may even be a third metal present in their composition.

**Sulphuric Acid without Lead Chambers.**—At the October meeting of the Liverpool section of the Society for Chemical Industry, Professor G. Lunge, the universally recognised authority on Chemical Industry, imparted some exceedingly remarkable words about the future of the Sulphuric Acid Manufacture. We think part of them are worth while reproducing: "We are confronted with the greatest revolution which has taken place since that acid became a commercial product in the days of Ward and Roebuck; a revolution beside which the invention of the Gay-Lussac and Glover tower, let alone that of plate columns, and the like, sinks into insignificance. I mean, of course, the total abolition of the vitriol chamber, and even of the use of nitrous fumes as oxygen carriers, by the use of the catalytic power of platinum, perhaps also by that of ferric oxide and other substances." . . . . Coming from so high an authority on the subject, such a statement must have set a great many manufacturers thinking. It need not be reminded that sulphuric acid is one of the most, if not the most, important of chemical manufactures. Moreover, it is essentially a British manufacture. The revolution of which Prof. Lunge speaks has perhaps a much greater reach than is anticipated at first sight, for sulphuric acid is the crude material for innumerable other industries, and all of these will be affected by the new process. Not only that the market price will be reduced by lower cost of production, but a great many industries will probably be able to make their own sulphuric acid by the new process when this was not possible by the old one. This comes from the fact that the plant for the manufacture by the new method is much cheaper, and takes up less space than by the older method. Moreover, the process is more simple and can be more successfully carried out on a smaller scale. The acid is exceptionally pure and especially free from arsenic. It is a gratifying sight to see that, as the first patent taken out in this direction was a British one, it was also a well-known British firm which was amongst the first to introduce the new method. We may add that we learn from a reliable authority that a factory working according to the new process is making its concentrated sulphuric acid at less than £1 per ton.

## MISCELLANEOUS.

**Motor Tests.**—The following are particulars of tests of some of Messrs. John Gibbs & Son's 2·48-in. diameter ventilating fans direct driven by patent enclosed dustproof motors, which machines have recently been completed for the Liverpool Corporation. These tests are as under:—

| Fan No. | Volts. | Amps. | H.P. | Revs. | Cub. ft. air p.m. | Temp. rise after run. |
|---|---|---|---|---|---|---|
| 189 | 230 | 11 | 3·4 | 470 | 30,000 | 39° F. |
| 190 | 230 | 11 | 3·4 | 490 | 29,000 | 34° F. |

The insulation resistance tested hot after run was for 189, 35 Ω; and for 190, 17 Ω.

**The New Factories Bill.**—There can be no doubt as regards the importance of this new Government measure. The whole tenor of the bill shows the desire of increasing the safety of the working classes. The Home Secretary, as soon as this measure has become a law, will be enabled to devise regulations for the safety of persons employed in dangerous trades, and the Bill provides a mode of procedure for the consideration of objections to such regulations, while in draft, by a referee, who is neither to be an inspector nor a person who would be affected by the proposed regulations. Children are not to be allowed to clean any place under machinery in motion, if there exists a possibility of their coming in contact with such machinery. All steam-boilers are to be provided with a proper safety valve, and with steam and water gauges; moreover, they must be cleaned at least once in three months, and be examined internally and externally by a competent engineer once in every twelve months. Thus, so far as factories are concerned, a regular boiler inspection is provided for. The Factory Acts, with certain modifications, will be applied also to laundries carried on by way of trade or for purposes of gain; special provisions secure the regulation of temperature and the carrying away of steam in the steam laundries; while the stoves for heating irons will have to be separated from the ironing-room, and the use of gas irons emitting noxious fumes will be prohibited. After January 1, 1904, all underground bakehouses, *i.e.* such as are more than 3 ft. below the surface of the footway of the adjoining street, must be certified of suitable construction. The Bill specifically prohibits the employment of children under 12 years of age. Some of the clauses deal with the two-shift system, with over-time, with out-workers, tenement factories, &c. Considering the wide application now-a-days given to the terms factory and workshop, the Bill will have a far-reaching influence.

**Water Purification.**—Messrs. Mather & Platt, Ltd., of Salford Ironworks, Manchester, have taken over the manufacture of the "Reeves" patent filter for the purification of water for manufacturing purposes, and have just issued an elegant illustrated *brochure*, descriptive of installations in actual operation. These deal with from six thousand to one-and-a-half million gallons per

day, and in every case they have proved highly efficient. The filters remove from 60 to 90 per cent. of the suspended matters, the most dangerous of the impurities to be found in water for manufacturing purposes.

**Devices for ridding Sea-water of the Salts held in solution** and to prevent their deposition on the interior of boilers of sea-going vessels are almost innumerable. They can by no means be considered as perfect, but the use of what may be termed "secondary" water has been seriously circumscribed through the presence in it of foreign matter. It has been stated that whilst many methods have been adopted for use inside a boiler to obviate the detrimental effects and serious complications arising from the presence of grease and other impurities, none have been sufficiently effective to warrant their continuance. The removal of all foreign substances from boiler feed-water is a most important factor in its use.

It may be interesting to note that amongst the few that would appear to comply more completely with the required conditions, the Harris Filter stands in a prominent position, in that it is being adopted exclusively throughout the British Navy, and H.M.S. *Leviathan*, one of the new 30,000 i.h.p. cruisers building at Messrs. Brown & Co.'s, Ltd., Clyde Bank, is to be fitted with these filters. It may be mentioned that the most important features in this apparatus are comprised in what is claimed as its self-cleaning property, its self-acting alarm when dirty, and relative solidity and inexpensiveness.

**The German Basic Steel Industry.**—Recent figures published by the *Verein deutscher Eisen und Stahl Industrieller*—the German Iron and Steel Association—show that the production of basic steel in the German Empire as a whole for the year 1899 was 5,667,050 tons—an increase of 601,154 tons on the output of the preceding year. Of this total output 3,973,225 tons were Bessemer and 1,693,825 tons were open-hearth steel. The total output of acid steel for the same year has not yet been ascertained. The total German make of Bessemer iron in 1899 was only about 550,000 tons, which would be equal to the production of about half a million tons of steel; but this quantity has probably been supplemented to a considerable extent by hematite pig-iron imports. The whole steel output of Germany in 1899 will most likely not have been below 6,100,000 tons. In 1890 it was less than one-half of that quantity; the steady progress of the industry, therefore, is most noteworthy.

**Belting—some Considerations.**—Belting is to machinery what the cable is to electricity—its artery for transmitting energy, and as the brilliancy of the electric light, or the speed of the dynamo, depends on the excellency of the cable, so does the success of a plant depend upon the excellency of the workmanship and of the material used in the construction of the belt for transmitting the power.

When a dealer has an order to place—and a consumer too, for that matter—he, as a rule, compares the belting of three or four firms, and at once picks out the thickest for the number of plies. Now there is a fallacy in this. Granted that the cloth used is, say, 32 oz. to the yard of 42 in. wide, then the quality of the thinner ones may be questionable; but it must be remembered that a 26-oz. cloth of loosely-woven structure will make a belt as thick as the 32-oz. Again, if the 32-oz. is thoroughly pressed and stretched, it will not be thicker than a 26-oz. belt not so treated. Everything therefore depends on the quality of the material and the way it is put together and finished. The belt not pressed and stretched is thicker to look at than the well-made one, but in use it will stretch and stretch again, and give endless trouble to the user.

In the case of composite textile belting more depends on the *way* the plies are cemented together, than on the quality of the cement used. To ensure complete contact and tenacity, the cementing should be done by hydraulic pressure under certain well-defined conditions to ensure perfect success. The cementing material must not only be melted but pressed into the very pores of the fabric, so that when it is cold it forms one solid mass, the textile fabric of which should be the finest and best that can be procured in the world, and guaranteed to withstand a temperature of 220°. Such a belt should have a textile breaking strain greater than any other composite belt. As far as we are able to determine, the claims of the manufacturers of "Teon" belting as fulfilling the above conditions are well based.

**Aluminium in India.**—The manufacture of domestic utensils of aluminium is making great strides in India. The work was originally started at the School of Arts, Madras, but there are now several other centres of manufacture, and the more general adoption of the metal is being hastened by the prevailing high prices of copper and tin. A large order for cooking vessels for the 28th Madras Infantry has recently been filled at the school. The vessels have almost of necessity to be made by hand, since each Native regiment has its own patterns. The production of a suitable water bottle is, however, a difficulty, as the flat pattern is not easily made in aluminium since soldering cannot be used; while a cylindrical pattern cannot be conveniently carried.

**Lighting Dues Proposed in the United States.**—An American shipping paper makes the following remarks:—"A great help in defraying the expenses for encouraging our merchant marine would be to follow the methods of England, in one particular. While the United States spends millions to furnish lights free to every craft entering her ports, England charges more than eleven thousand dollars light dues alone each year on one of our steamers plying between Liverpool and New York, charging for lights which the steamer never sees and is never expected to see. Not only did England compel the vessels to maintain

all her lights, but she made a profit of more than three-quarters of a million last year."

**A Single Rail Tramway.**—Lieut.-Colonel F. R. Burgess, in a paper read before the United Service Institution of India, describes the single-rail tramway invented by Mr. Charles Ewing. The system has been adopted on various Indian plantations and appears to be very suitable for the colonies and new countries where fairly good roads are in existence, and it might be practical in remoter agricultural districts in Europe also. It consists of a single rail weighing about 14 lb. to the yard, laid upon a level road, upon which the trucks are running, which are mounted on double-flanged wheels placed under the centre. The trucks are supported by a light iron balance-wheel, running on an axle which is pivoted at right angles to the centre, being kept in position by a horn-plate fixed to the frame of the truck. Excessive jolting of the balance-wheel when inequalities of the road are encountered is prevented by a helical spring fitted to the axle. The trucks have a width of 8 ft. or 9 ft., and are constructed of teak or other suitable timber fastened with nuts and bolts. In the Travancore Hills such a tramway, 22 miles in length, is in operation. The rolling stock consists of two-wheel trucks capable of carrying loads of 1 ton each, and it is estimated that on this line one pair of bullocks can draw a train of trucks, carrying six or seven tons, fifteen miles in a day, while to carry the same load in the ordinary way, sixteen to eighteen pairs of bullocks would be necessary.

**Economy in Reducing the Candle-Power of Gas.**—In consequence of the steady increase of the incandescent system of gas-lighting in Germany, proposals have been made to reduce considerably the candle-power of the gas provided, in order to cheapen its production. In Magdeburg, for instance, the question has been debated whether it might not be expedient to reduce the candle-power from 14 (its present value) to 10, or even to 8. Experiments made have shown that, when incandescent mantles are used, poor gas in some cases actually gives more light than the rich. Thus, in one series of experiments, an incandescent burner was supplied with gas, ranging in candle-power from 15 to 2, and it turned out that the latter gave the best light.

**Economy in Inferior Fuel.**—Mr. Bryan Donkin, M.Inst.C.E., has carried out some tests with different kinds of fuel in the same boiler, the conditions in every case remaining unaltered. The calculations were based on the comparison of the cost of fuel required to evaporate 1,000 gallons of water, and the results were as follows:—

| Kind of Fuel. | Cost per ton. | Water evaporated. | Cost per 1,000 gallons |
|---|---|---|---|
| | *s. d.* | lb. | *s. d.* |
| A. Dust coke ..... ..... | 5 0 | 6 | 3 8 |
| B. Dust Welsh coal ..... | 10 0 | 8 | 5 3 |
| C. Large Welsh coal ..... | 22 0 | 9 | 10 11 |

These figures clearly indicate the economy obtained by using inferior fuels, which, as a rule, are far cheaper, on a basis of calorific power, than the higher grades. By referring to the above table, it will be seen that a difference of 120 per cent. in the price of the fuel gives an increased efficiency of but 5·5 per cent., at an increase of cost of 108 per cent.

**Skin Wool in Germany.**—The German Credit Institute of Saxony has formed a Joint Stock Company for the production of skin wool, which heretofore has been produced almost exclusively in Southern France and Northern Italy. The United States Consul at Glauchau reports that glovers' wool has been produced in Germany in limited quantities, and the textile industries were compelled to obtain what they required of this article from the two countries above named. The term "skin wool" applies to the raw products of animal wools hitherto known as *raufwolle* (scraped wool). *Gerberwolle* (glovers' wool) is the wool or hair remaining after shearing on the skin of sheep—which while alive can, of course, not be sheared down to absolute nakedness—and taken from the hides of dead animals. The wool of slaughtered animals previously shorn is mostly of inferior quality and considerably shorter than that obtained from living sheep. It can be used therefore only for manufacturing inferior textiles, such as low-class flannels, &c. This so-called glovers' wool is principally removed from the skin by chemical means, and by this also loses its value for the wool industries. Skin wool, on the other hand, to quote from the *Journal of the Society of Arts*, is scraped off from the skins of dead sheep not shorn, and is, as a rule, longer, stouter, and more healthy and uniform than that obtained by shearing, because sheep-skins are mostly obtained from animals slaughtered for food, which must necessarily be sound, large, and healthy, whereas shorn wool is obtained as well from sickly decrepit animals, which are found in every flock. Skin wool is consequently likely to be more uniform in respect of fineness of quality, because in scraping the wool off the skin the coarser portions, which grow on certain portions of the body, can be sorted more carefully than is the case with shorn fleece. It is greatly preferred for certain purposes, for example, as abb wool (warp), owing to its tenacity and length. Where skin wool is desired, it is customary to allow the fleece to have a growth of from eight to twelve months. The process to be employed by the newly-founded company in Germany for obtaining such wool, and the commercial use intended, have not yet been made public.

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NOTE.—This section of the Magazine has been unavoidably curtailed this month owing to the demand for space elsewhere in the issue.

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In this section is presented every month a concise précis of the contents of the leading organs of the technical press and of the proceedings of learned societies throughout Great Britain, the Continent, and America, and also, in a summarized form, the subject matter of the more important articles appearing therein.

This systematic record should prove of the greatest value to those of our readers interested in one or more specific sections of technology, trade or economics, or to those who have insufficient leisure to peruse the large number of publications now appearing.

The following is an Index to the abbreviations used throughout the section. It gives an alphabetically-arranged list of the publications regularly reviewed, together with the place of publication and price. Should any of our readers desire further information we shall be happy to supply it.

| | | | |
|---|---|---|---|
| Advertisers' Review | London | 1*d.* | *Ad. Rev.* |
| American Machinery | New York | 10*c.* | *Am. Machy.* |
| American Machinist | New York | 6*c.* | *Am. Mach.* |
| American Manufacturer & Iron World | Pittsburg | $4 yr. | *Am. Mfgr. and Ir. Wld.* |
| American Shipbuilder | New York | 10*c.* | *Am. Shipbldr.* |
| Annales des Ponts et Chaussées | Paris | | *Ann. des Pts. et Chauss.* |
| Architect ... ... | London | | *Archt.* |
| Architectural Record | New York | | *Arch. Rcd.* |
| Architectural Review | Boston U.S.A. | 1*s.* | *Arch. Rev.* |
| Arms & Explosives | London | 6*d.* | *Arms and Exp.* |
| Australian Mining Standard | Sydney | 6*d.* | *Aust. Min. Stand.* |
| Australian Trading World | London | 2*d.* | *Aust. Trdg. Wld.* |
| Automotor and Horseless Vehicle Journal | London | 6*d.* | *Autom. and Horsel. Veh. Journ.* |
| Berg und Hüttenmannische Zeitung | Berlin | | *Berg Hüttenm. Ztg.* |
| Board of Trade Journal | London | | *Board of Tr. Journ.* |
| Book & News Trade Gazette | London | 1*d.* | *Bk. and Nws. Trd. Gaz.* |
| British Architect... | London | 4*d.* | *Brit. Archt.* |
| British & Colonial Druggist | London | 10*s.* yr. | *Br. and Col. Drgst.* |
| British & Colonial Printer | London | 2*d.* | *Bri. and Col. Prtr.* |
| British Printer ... | Leicester | 1*s.* | *Br. Prtr.* |
| Builder ... ... | London | 4*d.* | *Bldr.* |
| Bulletin de la Société d'Encouragement | Paris | | *Bull. d. l. Soc. d'Encour.* |
| Canadian Architect | Toronto | | *Canad. Archt.* |
| Canadian Electrical News | Toronto | | *Canad. Elec. News* |
| Canadian Engineer | Montreal | | *Canad. Engr.* |
| Canadian Manufacturer | Toronto | 8*s.* yr. | *Can. Mfgr.* |
| Canadian Mining Review | Ottawa | | *Canad. Min. Rev.* |
| Carriage Builders' Journal | London | 10*s.* yr. | *Carr. Bldrs'. Journ.* |
| Chamber of Commerce Journal | London | 1*s.* | *Chamb. of Com. Journ.* |
| Chemical Trades Journal | Manchester | 4*d.* | *Chem. Trds. Journ.* |
| Coach Builders' Art Journal | London | 25*s.* yr. | *Coachbldrs'. Art Journ.* |
| Cold Storage ... | London | 6*d.* | *Cold Storage* |
| Colliery Guardian | London | 6*d.* | *Coll. Guard.* |
| Commerce ... ... | London | 6*d.* | *Comm.* |
| Comptes Rendus de l'Acad. des Sciences | Paris | | *Compt. Rend.* |
| Contract Journal | London | 6*d.* | *Contr. Journ.* |
| Deutsche Techniker Zeitung | Berlin | 9 *mk.* 25 *pf.* yr. | *Deutsch. Techn. Ztg.* |
| Dingler's Polytechnisches Journal | Stuttgart | | *Dingler's Polyt. Journ.* |
| Diplomatic & Consular Reports | London & Washington | | *Dipl. and Cons Rpts.* |
| Echo des Mines ... | Paris & Brussels | 40 *fr.* yr. | *Ech. d. Mines* |
| Eclairage Electrique | Paris | | *Ecl. Elect.* |
| Electrical Engineer | London | 3*d.* | *Elec. Engr.* |
| Electrical Engineering | Chicago | | *Elec. Engrg.* |
| Electrical Review | London | 4*d.* | *Elec. Rev.*, London |
| Electrical Review | New York | 10*c.* | *Elec. Rev.*, New York |
| Electrical World... | New York | 10*c.* | *Elec. Wld.* |
| Electrician ... ... | London | 6*d.* | *Electn.* |
| Electricien ... ... | Paris | | *Electn.*, Paris |
| Electricity ... ... | London | 1*d.* | *Electy.*, London |
| Electricity ... ... | New York | 10*c.* | *Electy.*, New York |
| Elektrochemische Zeitschrift | Berlin | | *Elektrochem. Ztschrft.* |
| Elektrotechniker | Vienna | 12 *mk.* yr. | *Electrotechniker* |
| Elektrotechnische Zeitschrift | Berlin | | *Elektrotech. Ztschrft.* |
| Elettricita ... ... | Milan | | *Elettricita* |
| Engineer ... ... | London | 6*d.* | *Engr.* |
| Engineer ... ... | Cleveland U.S.A. | 5*c.* | *Engr.*, Cleveland |
| Engineering ... | London | 6*d.* | *Engrg.* |
| Engineering and Mining Journal | New York | 15*c.* | *Engrg. and Min. Jour.* |
| Engineering Magazine | New York & London | 1*s.* | *Engrg. Mag.* |
| Engineering News | New York | 15*c.* | *Engrg. News* |
| Engineering Record | New York | 12*c.* | *Engrg. Rcd.* |

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|---|---|---|---|
| English & Amer. Gazette | Paris | 20c. | *Engl. and Am. Gas.* |
| English Mechanic | London & New York | 2d. | *Engl. Mech.* |
| Gas Engineers' Magazine | Birmingham | 6d. | *Gas Engrs' Mag.* |
| Gas World ... ... | London | 6d. | *Gas Wld.* |
| Gaz, Le ... ... | Paris | 1 *fr.* | *Gaz* |
| Génie Civil ... ... | Paris | | *Gén. Civ.* |
| Gesundheits-ingenieur | Munchen | | *Ges. Ing.* |
| Glaser's Ann. f. Gewerbe und Bauwesen | Berlin | | *Glaser's Ann.* |
| Hardware, Metals & Machinery | London | 5*s.* yr. | *Hrdw., Mets. and Machy.* |
| Hardware Trades Journal | London | 6d. | *Hrdw. Trds. Journ.* |
| Heating & Ventilating | New York | | *Heatng. and Ventng.* |
| Ice & Cold Storage | London | 6d. | *Ice and Cld. Storge.* |
| Illustrated Official Journal of Patents | London | 6d. | *Ill. Off. Journ. of Pat.* |
| Indian & Eastern Engineer | Calcutta | R1. | *Ind. and East. Engr.* |
| IndianEngineering | Calcutta | | *Ind. Engrg.* |
| Industrie Electro Chimique | Paris | 60c. | *Ind. Elec. Chim.* |
| Industries & Iron... | London | 4d. | *Ind. and Ir.* |
| Invention ... ... | London | 1d. | *Inv.* |
| Irish Textile Journal | Belfast | 11*s.*6d. yr. | |
| Iron Age ... ... | New York | | *Ir. Age.* |
| Iron and Coal Trades Review | London | 6d. | *Ir. and Coal Trds. Review* |
| Iron & Steel Trades Journal | London | 3d. | *Ir. and Steel Trds. Journ.* |
| Ironmonger ... | London | 6d. | *Ironmgr.* |
| Journal of Commerce | Melbourne | 15*s.* | *Journ. of Comm.* |
| Journal of Electricity | San Francisco | | *Journ. of Elec.* |
| Journal of Electricity Power and Gas | San Francisco | 10c. | *Journ. of Electr. Power and Gas* |
| Journal of Gas Lighting | London | 6d. | *Journ. of Gas Lghtng.* |
| Journal Inst. Elec. Engrs. ... ... | London | 1*s.* | *Journ. of Roy. Inst. of Br. Archts.* |
| Journal of Royal Inst. of British Architects | London | 2*s.* | *Journ. of State Med.* |
| Journal of State Medicine | London | 6d. | *Journ. of Soc. of Arts* |
| Journal of the Society of Arts | London | 6d. | *Knowl.* |
| Knowledge ... | London | 1d. | *Ldry. Journ.* |
| Laundry Journal... | London | 4d. | *Ldry. Rec.* |
| Laundry Record ... | London | 2d. | *Lghtng.* |
| Lightning ... ... | London | 1d. | *Lit. Wrld.* |
| Literary World ... | London | 20c. | *Locom. Engrg.* |
| Locomotive Engineering | New York | 2*s.* 6d. yr. | *Loc. Mag.* |
| Locomotive Magazine | London | 8*s.* 6d. | *Machinery*, London |
| Machinery . . ... | London | | *Machinery*, New York. |
| Machinery ... ... | New York | 6d. | *Mach. Mark.* |
| Machinery Market | London | $5 yr. | *Mftrr.* |
| Manufacturer ... | Philadelphia | | *Marine Engr.* |
| Marine Engineer... | London | 6d. | *Mar. Engrg.* |
| Marine Engineering | New York | 6d. | *Mech. Engr.* |
| Mechanical Engineer | Manchester | 3d. | *Mech. Prog.* |
| Mechanical Progress ... ... | M'chr. | 1d. | *Mech. Wrld.* |
| Mechanical World | London | 22*fr.* | *Metall.* |
| Metallurgie ... | Paris | 5d. | *Miller* |
| Miller ... ... | London | 6d. | *Min. Journ.* |
| Mining Journal ... | London | 6d. | *Ming. Wld.* |
| Mining World ... | London | | *Mitt. a. d. Kgl. Tech. Versuchsanst*, Berlin |
| Mitt. aus d. Kgl. Tech. Versuchsanst | Berlin | | *Modern Machy.* |
| Modern Machinery | Chicago | $1 | *Mois Scient.* |
| Mois Scientifique | Paris | $1.50 | *Nat. Ldry. Journ.* |
| National Laundry Journal | Chicago | 15c. | *Nature* |
| Nature .... ... | London | 6d. | *Nature*, Paris |
| Nature ... ... | Paris | | *Naut. Gaz.* |
| Nautical Gazette ... | New York | 10c. | *Oest. Monatsschr. f. d. Oeff. Baudienst* |
| Oest. Monatsschr. f. d. Oeff. Baudienst | Vienna | | *Oest. Zeitschr. f. Berg u. Hüttenwesen* |
| Oest. Zeitschr. f. Berg und Hüttenwesen | Vienna | | *Pap. and Plp.* |
| Paper & Pulp ... | London | 6d. | *Power* |
| Power ... ... | New York | 10c. | *Pract. Engr.* |
| Practical Engineer | London | 2d. | *Pub. Hlth. Engr.* |
| Public Health Engineer | London | 3d. | *Rail. Engr.* |
| Railway Engineer | London | 1*s.* | *Rail. and Engng. Rev.* |
| Railway & Engineering Review | Chicago | $5 | *Rail. Mag.* |
| Railway Magazine | London | 6d. | *Railw. Mast. Mech.* |
| Railway Master Mechanic | Chicago | $1.50 | *Rail. News* |
| Railway News ... | London | 6d. | *Rail. Off. Gaz.* |
| Railway Official Gazette | London | 1d. | *Rail. Rcd.* |
| Railway Record ... | London | 6d. | *Railw. Wrld.* |
| Railway World ... | London | | *Rev. Min.* |
| Revista Minera ... | Madrid | 25*fr.* | *Rev. d. Chim. Ind.* |
| Revue de Chimie Industrielle | Paris | 15*fr.* | *Science Abstr.* |
| Science Abstracts | London & New York | 2*s.* | *Sci. Am.* |
| Scientific American | New York | $4 yr. | *Sci. Am. Suppl.* |
| Scientific American Supplement | New York | $5 yr. | *Shpng. Wrld.* |
| Shipping World ... | London | 6d. | *South Afr.* |
| South Africa ... | London | 6d. | *Stahl u. Eisen* |
| Stahl und Eisen ... | Dusseldorf | 24 *mk.* yr. | *Steamsh.* |
| Steamship ... ... | Leith | 6d. | *Stone* |
| Stone ... ... | New York | | *Survr.* |
| Surveyor ... ... | London | 6d. | *Syr.* |
| Syren ... ... | London | 3d. | *Text. Ind.* |
| Textile Industries | Bradford | 10*s.* yr. | *Text. Merc.* |
| Textile Mercury ... | Manchester | 1d. | *Text. Rcdr.* |
| Textile Recorder | Manchester | 12*s.* yr. | *Text. Ztg.* |
| Textil-Zeitung .. | Berlin | 16 *mk.* yr. | *Trde. and Fin.* |
| Trade & Finance... | London | 1d. | *Trde. and Ind.* |
| Trade & Industry | Manchester & London | 6d. | *Trde. Journ. Rev.* |
| Trade Journals Review | London | 6d. | *Tramw. and Railw. Wld.* |
| Tramway & Railway World | London | 1*s.* 3d. | |
| Transactions of the Inst. of Naval Architects ... | | | |
| Trans. Inst. Engrs. & Shipbuilders... | Glasgow | | |
| Trans. Soc. Engrs. | | | |
| Western Electrician | Chicago | 10c. | *West. Electn.* |
| World's Pulp & Paper Industry | London | 6d. | *Wld's. Pulp and Ppr. Ind.* |
| Zeitschr. d. Oest. Ing. u. Arch. Ver. | Vienna | 30 *fr.* yr. | *Zischrft. d. Oest. Ing. u. Arch. Ver.* |
| Zeitschr. d. Ver. Deutscher Ingen. | Berlin | | *Ztschrft. d. Ver. Deutsch. Ing.* |
| Zeitschrift für Elektrochemie | Halle a. S. | 16 *mk.* yr. | *Ztschrft. f. Elektrochem.* |
| Zeitschrift für Elektrotechnik | Halle a. S. | | *Ztschrft. Elektrotech.* |

## ARCHITECTURE AND BUILDING.

### 1. Construction and Design.

**Central Station Buildings.**—*The Design and Construction of Central Stations.* Report of a lecture delivered by Mr. C. Stanley Peach at Carpenters' Hall on March 1st. The author dwells on the fact that central station buildings are by no means necessarily homely sheds, but possess many points capable of architectural expression, while in regard to special points of construction they are, even in the present stage, full of interest. 7¼ cols. —*Bldr.*, March 10th, 1900.

**Court Building.**—*The New House of the New York Supreme Court of Appeal.* Account of an extensive and practical building in New York, specially designed with the object of facilitating the work of the Court of Appeals. (Ill.) 2 cols. —*Engrg. Recd.*, Jan. 6th, 1900.

**Exterior of Buildings.**—*The Exterior Treatment of Sharp or Acute Angles in Street Buildings.* Paper by Mr. A. W. Hennings, read before the Architectural Association, dealing with a problem that sooner or later will have to be met with in the practice of the architect. (Ill.) 9½ cols. *Bldr.*, March 3rd, 1900.

**Mausoleum.**—*The Somerton Hills Mausoleum.* Description of a mausoleum characterised by several notable features, notably the construction of double walls and roofs for ventilating purposes. 1⅝ col. *Engrg. Recd.*, Dec. 30th, 1899.

**Portal.**—*The Paris International Exhibition.* The present article deals with the Monumental Entrance, which gigantic portal is to be one of the *clous* of the exhibition, but which, in the opinion of many, will be a discordant note in the admirable harmony of the Place de la Concorde. (Ill.) 2 cols. *Engrg.*, March 9th, 1900.

**Modern House.**—*The Design of a Modern Apartment House.* Description of the various mechanical data that have to be kept in view in planning a modern dwelling house, such as are required as apartment houses in New York. 4¼ cols. *Engrg. Recd.*, Jan. 20th, 1900.

**Old Halls.**—*Old English Halls and Mansions.* Lecture delivered by Prof. Roger Smith, on Feb. 22nd, at Carpenters' Hall, on the interesting subject of ancient English halls, which underwent many transformations, but yet retained the original character. 5½ cols. *Bldr.*, March 3rd, 1900.

### 2. Heating, Ventilation and Sanitation.

**Dangerous Dusts.**—*Dangerous Air Dust.* Abstract of a paper by John Gormby, read at a meeting of the Heat. and Vent. Engrs., describing air dusts so constructed as to admit sewer gas into the building. ½ col. *Engrg. Recd.*, Jan. 27th, 1900.

**Heating.**—*Ventilation and Heating of a Baltimore School House.* Description of a system of mechanical draught heating employed for the purpose of heating a school-house, and applicable in any building situated in a country where the climate is temperate. 1½ col. *Engrg. Recd.*, Jan. 6th, 1900.

—— *Ventilation and Heating of the Rockwood Pottery, Cincinnati.* Description of the plant erected for the heating of an extensive pottery devoted to the highest branches of ceramics. 2 cols. *Engrg. Recd.*, Jan. 6th, 1900.

—— *The Rating of Steam and Hot-water Boilers for Heating Purposes.* By James Mackay, Chicago, Ill. Abstract of a paper read at the New York meeting of the Am. Society of Heating and Ventilating Engrs. The author is of opinion that it would be a distinct advantage if the varying conditions were made to harmonise and standards established upon which to base capacity of boilers. 2½ cols.—*Engng. News*, Feb. 15th, 1900.

**Heating.**—*Heating a Locomotive Boiler-Shop.* Describes the test of a practical heating system, and gives a diagram showing the effect of velocity in increasing relative condensation in heater.—*Loc. Engrg.*, Feb., 1900.

**Lighting and Heating.**—*Light, Heat, and Power at the Kankakee Hospital.* Description of the very complete installations for the above purpose at the Illinois Eastern Hospital for the Insane at Kankakee, Ill., U.S.A. (Ill.) 3½ cols.—*West. Elect'n.*, March 3rd, 1900.

**Sanitation.**—*Health in the Workshop.* Paper read by Mr. J. D. Sutcliffe before the Manchester Association of Engineers, Feb. 24th, in which the author gives many practical hints regarding factory sanitation, culled from the experience gained in the past eighteen years. (Ill.) 19 cols.—*Trans. Manchester Ass. Engrs.*, Feb., 1900.

**Steam Condensation.**—*Condensation of Steam in Blower System of Heating.* The article describes experiments made for the purpose of determining the amount of heat transmitted under different conditions of velocity by a blower working under conditions similar to those required for hot-blast heating. The blower employed stood 80 in. high, and had a circular inlet 30 in. in diameter, and a square outlet 26½ in. by 26½ in. 5 cols.—*Engrg.*, Feb. 1st, 1900.

**Steam Heating and Ventilation.**—*Modern Practice in Steam-Heating and Ventilation* (Chap. VI.). The present instalment deals with Piping and Construction Details. The author, Mr. William S. Monroe, describes very fully how to lay out the system of piping, and to arrange the various details of construction. (Ill.) 8½ cols. —*Engrg. Recd.*, Feb. 17th, 1900.

### 3. Plumbing and Gasfitting.

**Plumbing.**—*Plumbing in the Dun Building, New York.* Description of the plumbing work in a fifteen-story office building in which the necessary pressure on the pipes is supplied by compressed air cylinders located in the basement, instead of using tanks on the roof. 2 cols.—*Engrg. Recd.*, Jan. 20th, 1900.

### 4. Miscellaneous.

**Structural Iron.**—*Details of Structural Iron and Steel* (Pt. 8). The present instalment deals with unit forms and sections, beginning with the unit sections that are available for structural work. (To be continued.) 4½ cols.—*Bldr.*, March 3rd, 1900.

## CIVIL ENGINEERING.

### 1. Bridges.

**Bridges.**—*Falsework for Erecting the Manhattan Towers and End Spans, New East River Bridge.* By C. E. Fowler, M. Am. Soc. C. E., Consulting Engineer for the Terry and French Construction Co., New York City. Description of the falsework for erecting the above bridge, which will have steel towers from a point 20 ft. above mean high water, and, unlike the old Brooklyn Bridge, which has the back stays loaded, will have steel approach spans entirely unsupported by the cables. (Ill.) 6½ cols. *Engrg. News*, March 8th, 1900.

—— *The Interprovincial Bridge, Ottawa, Canada.* Description of a bridge across the Ottawa river at Nepean Point which will connect the city of Ottawa, in the province of Ontario, with the city of Hull, province of Quebec, and have a total length of 2,286·75 feet between abutments. It is to be built entirely of mild steel, and consist of pipe-connected truss spans over the river, and a long plate-girder approach viaduct at the north end. (Ill.) 5½ cols.—*Engrg. Recd.*, March 10th, 1900.

—— *The Alexandre III. Bridge, Paris.* Description of the new handsome bridge which unites the

different portions of the Exhibition near the Champs Élysées, and forms part of the principal avenue to be called Esplanade des Invalides. (Ill.) 2½ cols.—*Sci. Am.*, March 10th, 1900.

**Bridges.**—*Rolling Lift Bridge at the Boston Terminal, N. Y., N. H. & H. R. R.* Description of an interesting type of bascule bridge which has been introduced within the past few years by Mr. William Scherzer, M. Am. Soc. C. E. (Ill.) 6½ cols.—*Engrg. News*, March 15th, 1900.

—— *The Latest of the large Mississippi Bridges.* Description of a bridge of a symmetrical structure, forming part of a new line of railroad connecting the cities Davenport and Clinton, Iowa, with Rock Island and Molière. (Ill.) 1½ col.—*Sci. Am.*, March 17th, 1900.

—— *Tests of Small Model Cement Arches to Determine the Value of Rods.* By Daniel B. Luten. Description of a design of an arch bridge having timber ties from one abutment to the other beneath the bed of the stream to sustain the horizontal thrust of the arch. (Ill.) 3 cols.—*Engrg. News*, Feb. 15th, 1900.

**Bridge Construction.**—*The Designing of Skew Connection Details for Roof and Bridge Work.* By C. A. P. Turner, C.E. The article deals with skew details, such as are found in roofwork, skew portals of bridges, etc., which cause the inexperienced draughtsman considerable worry, and not unfrequently also more experienced men are puzzled by them. 8½ cols.—*Engrg. News*, Feb. 15th, 1900.

**Bridges.**—*The Lehigh Valley Railroad Bridge at Easton, Pa.* Description of a single-track bridge supported by eight piers and one abutment which crosses the Lehigh river at Easton, Pa. 4½ cols.—*Engrg. Recd.*, Feb. 10th, 1900.

## 2. Canals, Rivers and Harbours.

**Canals.**—*The Heinrichenburg Ship Elevator on the Dortmund-Ems Canal.* Description of one of the most unique features of the Dortmund-Ems Canal, Germany, namely, the ship elevator, the construction of which on such a scale represents an innovation in the working of canal traffic. (Ill.) 5 cols.—*Mech. Prog.*, March, 1900.

—— *What shall New York do with its Canals?* Somewhat condensed reproduction of the report of the Commission appointed by Governor Roosevelt in March last to investigate and decide upon the wisest policy for the State of New York to pursue towards its canals, which on Jan. 15th was presented to the Governor. 18 cols.—*Engrg.*, Feb. 1st, 1900.

**Nicaragua Canal.**—*The Nicaragua Canal Bill in Congress.* Summary of the Nicaragua Canal Bill. The effort to pass it through Congress under the authority of the Secretary of War, without waiting for the report of the Isthmian Canal Commission, appointed by the President, lends a special interest to this measure. 1 col.—*Mftr.*, Feb. 1st, 1900.

**Dams.**—*The Assouan Dam on the Nile.* Description of the great Nile dam which is being built to develop the large area, nearly one-third of all Egypt, which is undeveloped for want of water, and also to render more certain the perennial irrigation of other portions. (Ill.) 3½ cols.—*Engrg.*, March 9th, 1900.

**Embankments.**—*The Closing of Breaches in Sea and River Embankments.* Paper read by Mr. Richard F. Grantham, M. Inst. C.E. The author, referring to three serious breaches caused by the great tide of November, 1897, in the river walls of Northey Islands in the Black Water below Maldon, Essex, expresses the opinion that instead of attempting to pile across the breaches, the cheaper plan, and one with the least risk, would be to form an inset or horseshoe wall round the breach.—*Trans. Society of Engineers*, March 5th, 1900.

**River Regulation.**—*Proposed Improvements of the South-West Pass at the Mouth of the Mississippi.* Sketch of the proposed improvement of the South-West Pass at the mouth of the Mississippi River, for which a board of engineers was appointed to report upon a project for obtaining a navigable depth of 35 feet at mean low water. 3 cols.—*Engrg. News*, Feb. 15th, 1900.

**Rivers.**—*The Waterways of Russia.* By C. H. Moberly, M. Inst. C.E. (Continuation.) The instalment deals with the waterways of Siberia, the Yana and Koldma, the Lena, the Enisei, the Angara, the Ob, the Tom, the Choulim, the Ket, the Vāeg, and the Toura. (To be continued.) 4½ cols.—*Engrg.*, March 2nd, 1900.

**Labour.**—*Hand and Machine Labour.* (Continued.) The present instalment deals with envelope-making, files, and firearms. (To be continued.) 3 cols.—*Engrg.*, March 9th, 1900.

## 3. Irrigation.

## 4. Miscellaneous.

# ELECTRICAL ENGINEERING.

## 1. Electro-Chemistry.

**Ammonia.**—*Some Properties of Liquid Ammonia.* By C. Frenzel. Results of experiments regarding the properties of pure ammonia liquefied by pressure at a low temperature, whose physico-chemical relations in many ways strongly resemble those of water. 7 cols.—*Ztschrft. f. Electrochemie*, March 22nd, 1900.

**Electro-Chemistry.**—*Calcium Carbide Manufacture in connection with Iron Works.* By Mr. Liebetanz, Engineer, Düsseldorf. The author points out the great advantage to be obtained from the use of furnace gases in the manufacture of calcium carbide where there is no water-power to be obtained. (Ill.) 12 cols.—*Stahl u. Eisen*, March 1st, 1900.

—— *Calcium Carbide Manufacture in connection with Iron Works.* By Mr. Liebetanz, Engineer, Düsseldorf. (Conclusion.) (Ill.) 12½ cols.—*Stahl u. Eisen*, March 15th, 1900.

—— *The Production of Iron and Steel in the Electric Furnace.* Description of the furnace designed by the Italian engineer, Stassano, for the production of iron and steel by the electric arc. (Ill.) 1½ col.—*Mech. Engr.*, March 3rd, 1900.

—— *Which place should Electro-Chemistry occupy in the Chemical Course of the University?* The author, Mr. F. Foerster comes to the conclusion that electro-chemistry should be treated as all other branches of chemistry, and requires no special course of instruction. 8½ cols.—*Ztschrft. f. Electro-chemie*, March 1st, 1900.

—— *Electro-Deposition of Copper from Alkaline Solutions.* By Sherard Cowper-Coles. One of the most recent applications of electro-deposition of copper is for the purpose of coating, with metallic copper, zinc sheets, which are used for a variety of purposes. The author describes the process. (Ill.) 1½ col.—*Elec. Rev.* (London), Feb. 16th, 1900.

**Electrolysis of Copper.**—*An Electrolytic Centrifugal Process for the production of Copper Tubes.* By Sherard Cowper-Coles. 16 cols.—*Journ. of the Inst. of Elec. Engrs.*, March 1900.

—— *Cure of Electrolysis by Independent Returns.* Abstract of a paper by C. A. Newbaker, reproduced from the "American Electrician" in which the author outlines a remedy for the electrolysis of underground piping by stray currents. 6½ cols.—*Gas Wrld.*, March 17th, 1900.

## 2. Electric Lighting.

**Charging for Electric Supply.**—*The Maximum Demand System of Charging for Electrical Energy.*

This system, which is very widely adopted in this country, and is one of the most rational in existence, is not easy to grasp at first, and the author takes pains to explain its working so that it can be understood by the uninitiated. 3 cols.—*Elec. Rev.* (London), March 2nd, 1900.

**Electric Lamps.**—*The Nernst Lamp.* By W. M. A. Johnson. Description of the recent models of the Nernst Lamp, which has been so perfected that the German Company have decided to subject it to the test of commercial usage. 1¼ col.—*Elec. Wrld. and Engr.*, March 3rd, 1900.

—— *New "Wood" Focussing Lamp.* Description of a lamp designed for the purpose of making the focussing mechanism entirely distinct from and independent of the feeding mechanism. The carbon guides used in other lamps are abandoned, thus avoiding heavy shadows and reduction of effective candle-power. 1¾ cols.—*Elec. Wrld. and Engr.*, Feb. 27th, 1900.

**Electric Lighting.**—*Electric Lighting of Railway Carriages by a Dynamo Driven by the Axle.* Description of the two best-known systems, *i.e.* the system of Stone and the system of Dick. 3½ cols.—*Dingler's Polyt. Journ.*, Feb. 24th, 1900.

—— *On Electric Lighting Cable Breakdowns.* Translation of an article by Gisbert Kapp in the "Electrotechnische Zeitschrift," in which the author explains the causes of the breaking down of cables whose inner conductors remain switched in while the outer is interrupted. (Ill.) (To be continued.) 3½ cols.—*Elec. Rev.* (London), March 9th, 1900.

**Electric Wiring.**—*Electric Wiring of Buildings.* By Mr. W. A. Chamen. A paper describing the various methods in use for the wiring of buildings, and discussing their efficiency and the obstacles to be met with in the execution of the work. 13½ cols.—*Trans. Inst. Engrs. and Shipbldrs., Scotland*, Jan. 1900.

## 3. Power.

**Dynamos.** *Some Mechanical Details of Dynamo Design.* By E. Kilburn Scott. There are a number of minor details in the manufacture of dynamos which, taken individually, may appear insignificant, but, taken together, make a great difference in the value of the machine. To these the author devotes his comments. (To be continued.) 3½ cols.—*Elec. Rev.* (London), March 2nd, 1900.

**Electric Annealing.** *The Electric Process of Annealing Armour Plate in the Construction of Warships.* By Charles J. Dougherty. Abstract of a paper read Dec. 16th, 1899, before the Engineers' Club, of Philadelphia, and describing the very successful annealing of Harveyised and Krupp plates by the use of electricity. 5¾ cols.—*Electricity* (New York), March 14th, 1900.

**Electric Fans.** *Electric Fans and Fan Motors for 1900.* Ten pages are devoted to different types and makes of electric fans. The Lundell electric fans, as manufactured by the Sprague Electric Co., are placed first in the list, and it is stated that the design of the fan blades has been considerably improved, which enables the new types to furnish larger quantities of air without increasing the consumption of power. Other fans are also described, showing rather a peculiarity of shape than any other distinctive feature. Although the article deals chiefly with small fans, the type manufactured by the Sturtevant Engineering Co. is also described. This type is made from 18 in. in diameter to 10 ft., and capable of dealing with from 2,000 to 175,000 cubic feet of air per minute. 18 cols.—*Elec. Rev.* (New York), Feb. 14th, 1900.

—— *Electric Fans and Fan Motors for 1900.* (Continued.) The present instalment deals with Westinghouse fan motors, Warren Electric and Specialty Co.'s fans, general electric fan motor, Backus electric fans, water motor fans, Tuerk alternating-current fans and Fuller fans. (Ill.) 6½ cols.—*Elec. Rev.*, Feb. 21st, 1900.

**Electric Plant.** *Electricity in Country Houses.* Abstract of a volume of that title published by Messrs. E. Scott and Mountain, of the Close Works, Newcastle-on-Tyne. This volume is devoted to illustration of country-house work carried out by the firm, and in each case a small amount of letterpress is given to explain the character of the work and the plant. (Ill.) 1 col. —*Elec. Engr.*, March 9th, 1900.

—— *City Road Electric Supply Station.* Description of the City Road station, London, designed and constructed by Mr. A. J. Lasson, of the County of London and Brush Provincial Electric Lighting Co., Ltd. (Ill.) 3 cols.—*Engr.*, Feb. 23rd, 1900.

—— Description of a plant supplying light and power in one of the gigantic buildings of New York, having 34 stories from cellar to dome and a height of 424 feet. The lighting comprises 7,500 incandescent lamps. (Ill.) 4 cols.—*Mech. Prog.*, March, 1900.

—— *The County of London Electric Lighting Company's Electricity Works.* Description of these works, which supply at present seven of the 45 London districts, and which were designed by Mr. A. J. Lasson, Engineer of the Company. (Ill.) 7 cols.—*Elec. Rev.* (London), March 9th, 1900.

—— *The Power House of the St. Lawrence Power Company, Massena.* Description of the very interesting hydraulic plant of the St. Lawrence Power Co., at Massena, St. Lawrence County, N.Y., which is now approaching completion after 16 months of active construction. (Ill.) 3½ cols. —*Engrg. Recd.*, Feb. 10th, 1900.

—— *The Electricity Works of the County of London and British Provincial Electric Lighting Company.* Full description of the Wandsworth electricity supply station and its working. (Ill.) 8½ cols.—*Elec. Engr.*, March 2nd, 1900.

—— *Bromley Electricity Works.* Description of an electric plant, situated in a very pleasant semi-rural neighbourhood, consisting of boiler house, engine room, cell room, and meter room, to which considerable additions will be made in the near future. (Ill.) 3¾ cols.—*Elec. Rev.* (London), Feb. 16th, 1900.

—— *An English Direct-Current High-Tension Central Station.* Description of the central station recently installed at Bromley, Kent. The district supplied includes the town of Bromley, which offers a fair compact load, chiefly from shops and a large hotel, and the village of Chislehurst, 2½ miles distant. (Ill.) 3½ cols.—*Elec. Wrld. & Engr.*, Feb. 17th, 1900.

—— *The Willesden Works of the Metropolitan Electric Supply Company.* The site on which the new works are erected is about 8½ acres, partly in Willesden and partly in Acton. The estimated capacity of the works when completed will amount to 4,500 i.h.p. or 27,000 kw., and will be capable of providing for 1,620,000 lamps. (To be continued.) (Ill.) 5 cols.—*Elec. Engr.*, March 9th, 1900.

**Electrical Transmission.**—*Practical Limitations of Electrical Power Transmission.* Reproduction of an article in "Cassier's Magazine" by Dr. Louis Bell, in which the author comes to the conclusion that a transmission of a thousand or two kilowatts over 150 to 200 miles in a favourable climate is not only desirable but feasible. 4½ cols. *Electricity* (London), March 2nd, 1900.

—— *A Field for Long-Distance Transmission.* By Louis Bell. The article deals with the practical limits of long-distance transmission and their causes, the possibilities of Mexico, calculation for a long line, and the engineering value of transmission to great distances. 3 cols.—*Elec. Rev.* (New York), March 7th, 1900.

**Electrical Transmission.**—*The Utilisation of the Schaffhausen Water Power.* By Alfred Amsler, Ph.D. Description of former installations of water-wheels for utilising the water-power of the Rhine and of the modern electric plant. 5½ cols.—*Journ. of the Inst. of Elec. Engrs.*, March 1900.

—— *The Economics of Long-Distance Electric Power Transmission.* By Mr. Alton D. Adams, M.Am.Inst.Elec.E. The author strongly remonstrates against the idea that transmission of power by electricity over such a distance is economical and can compete with steam power in Illinois, where fuel is cheap. 3 cols.—*Engrg.*, Feb. 1st, 1900.

—— *The Mount Whitney Power Transmission.* By Robert McF. Doble. Full description of the installation and working of this interesting enterprise in the San Joaquim Valley, Cal., U.S.A. (Ill.) 17 cols.—*Journ. of Elec. Power and Gas*, Jan. 1900.

—— *The Willesden Electricity Works of the Metropolitan Electric Supply Company, Limited.* Description of one of the most important electrical undertakings in Great Britain. (To be continued.) 3½ cols. (Ill.)—*Elec. Rev.* (London), March 23rd, 1900.

**Electric Meters.**—*Combined Gravity Ammeter and Voltmeter.* Description of a meter of the gravity type, there being no permanent or electro-magnet used in its construction. The makers claim that, in consequence, it never requires re-calibrating; but it is not free from errors due to external magnetism. (Ill.) ½ col.—*Elec. Engr.*, Feb. 16th, 1900.

**Electric Motors.**—*Large Induction Motors for Paris.* Description of several induction motors recently shipped to France by the Westinghouse Electric and Manufacturing Company. They are rated at 850 h.-p. each, and are said to be the largest induction motors yet made. (Ill.)—*Elec. Wrld. and Engr.*, March 3rd, 1900.

—— *Warren Inductor Type Alternator.* Description of a 250 kilo-watt machine built to induce magnetism and generating the current delivered, by the Irwin Electric Light and Power Co. It is claimed for the machine that it requires very little attention, is simple and compact, and the supplies and repairs are reduced to a minimum. (Ill.) 1½ col.—*Am. Mftrr.*, March 8th, 1900.

—— *Electrical Equipments for Motive Power.* General comments on the better-known examples of electric motors. The present instalment is specially devoted to the Polyphase Induction Motor, Westinghouse type "C." (Ill.) 3½ cols.—*Mech. Prog.*, Feb. 1900.

—— *The Adams Motor.* Description of a small motor constructed by Adams and Co., Lowestoft, suitable for carriage builders, cycle manufacturers, etc. (Ill.) 1½ col.—*Electricity*, March 23rd, 1900.

—— *Westinghouse Type "C" Induction Motors.* Description of a type of induction motors, which admits of a wide and varied application in numerous industries. The largest size at present constructed is rated at 850 horse-power. (Ill.) 2 cols.—*Engr.* (Cleveland), March 1st, 1900.

—— *A Portable Electric Power Installation.* The article deals with an ingenious method for using drills, milling cutters, reamers, &c., propelled by electric motor through the agency of a flexible shaft; an interesting feature is the method adopted for securing an exceedingly accurate range of speed revolution in the motor. The multi-speed motors illustrated are manufactured by the Stow Manufacturing Co., of Binghamton, N.Y., under patents granted to F. A. Johnson, covering the principle of varying the field magnetism at the centre of the pole piece, to vary the speed without sensibly altering the commutating field at the pole tips. 2 cols.—*Elec. Rev.* (New York), Feb. 23, 1900.

—— *Some Notes on Balancing and Boosting Sets.* The article deals with the balancer, its function and design, and notices how these are affected by the addition of the boosters to the balancing set. 3½ cols.—*Elec. Rev.*, March 2nd, 1900.

**Overhead Lines.**—*On Construction of Overhead Equipments.* The author gives a brief account of the work of construction of an overhead line for tramway work, with a view of pointing out some of the difficulties that have been encountered. (Ill.) 4 cols. and 2 cols. respectively.—*Elec. Rev.*, Feb. 23rd and March 2nd, 1900.

## 4. Telegraphy and Telephony.

**Telegraphy.**—*The Pollak-Virag System of Telegraphy.* By Chas. H. Garland. Description of this interesting system for increasing the carrying capacity of the expensive trunk lines, and permitting the transmission of 10,000 ten-word telegrams per hour. (To be continued.) 1¾ and 2½ cols, respectively.—*Elec. Rev.* (London), March 16th and 23rd, 1900.

—— *Recent Progress in Wireless Telegraphy.* By G. Marconi. Abstract of a lecture by the author, delivered at the Royal Institution, Feb. 2nd, 1900. 5½ cols., March 3rd, 1900.

—— *Wireless Telegraphy.* An article by Emile Guarini-Foresio, translated from a paper recently read at a meeting of the Belgian Electric Association, describing the Guarini Automatic Repeater, which does for wireless telegraphy what the relay does for ordinary telegraphy. (Ill.) 4 cols.—*Electricity* (New York), Feb. 14th, 1900.

—— *Fire-Alarm and Police-Telegraph System, Los Angeles.* The City of Los Angeles, Cal., U.S.A., recently installed one of the most complete automatic fire-alarm and police-telegraph systems in existence, which is described in the present article. (Ill.) 2 cols.—*Elec. Wrld. and Engr.*, Feb. 17th, 1900.

—— *Electro-Mechanical Battle-Order Telegraph.* Reproduced article from the "Proceedings of the United States Naval Institute," described an instrument designed by Lieutenant-Commander Seaton Schroeder, U.S.A., serving for the automatic transmission of orders on a war-vessel during battle. (Ill.) 5 cols.—*Elec. Rev.*, Feb. 7th, 1900.

**Telephones.**—*The Energy of Telephone Currents.* By Eugene W. Caldwell. The experiments described in the article were made some time ago by Professor Blake and the author, in order to determine under what conditions of battery induction-coil and adjustment of contacts, a transmitter would give the best results. 4 cols.—*Electricity.* (London), March 2nd, 1900.

——*Telephonic Development in Japan.* Description of several telephone-exchanges in Japan controlled by the Government, the working of which seems to be quite up-to-date, and need not fear comparison with the exchanges in Occidental Countries. (Ill.) 1 col.—*Elec. Wrld. and Engr.*, March 3rd, 1900.

## 5. Miscellaneous.

**Atomic Theory.**—*The Downfall of the Atomic Theory.* The article deals with the remarkable experiments and theory of Mr. J. J. Thomson, according to which the so-called atom is not an indivisil le unit, but consists of numerous smaller units which he calls "Corpuscles." This entirely unsets Dalton's atomic theory. 3¾ cols.—*Elec. Rev.* (London), March 2nd, 1900.

**Accumulators.**—*Storage Battery Problems.* By E. J. Wade. The author in the present instalment mainly discusses some of the chemical and theoretical questions connected with lead cells. 5½ cols.—*Elec. Engr.*, March 23rd, 1900.

**Chemical Elements.**—*New Gases and Rare Earths.* Abstract of an article by Prof. O. N. Witt in the "Journal für Gasbeleuchtung," in which the author shows that one of the curious effects of the attention which has been drawn to the rare earths has been to throw our chemical

theories into confusion, and that the same result has followed the study of the gases in the atmosphere. 2¼ cols.—*Gas Wrld.*, March 24th, 1900.

**Electrical Apparatus.**—*The Electrical Collections in the Smithsonian Institution and the National Museum.* A continuation of an article by Mr. George G. Maynard, which appeared in the same paper on Jan. 3rd, 1900.

**Electrical Applications.**—*An Electrical Engraving Process.* By Mr. S. Amstutz. The author describes a mechanism which is the out-growth of investigations made by him in the field of photo-telegraphy begun as early as 1884. The fundamental principle consists in producing a variation in an electric circuit, corresponding to the variations of the lights and shades of a photograph. (Ill.) 6 cols.—*Elec. Wrld. and Engr.*, Feb. 17th, 1900.

**Electrical Engineering.**—*American Electrical Engineering Standardisation.* By C. F. Guilbert. Some comments and criticisms on the report of the Standardisation Committee of the American Institute of Electrical Engineers. 5 cols.—*Elec. Wrld. and Engr.*, March 3rd, 1900.

**Electric Power Transmission.**—*The Status of High-Voltage Industry in Austria-Hungary.* Abstract of an article by Emil Honigmann, Vienna, in the Electrotechn. Ztg., Berlin, which contains many points of interest. (To be continued.) 3½ cols.—*Electro-Techniker*, March 15th, 1900.

**Electro-Therapy.**—*Finsen's Photo-Therapy.* By S. D. Benoliel. Description of an arc-light apparatus designed by Finsen, of Copenhagen, for the cure of certain diseases, such as lupus, etc. The lamp is constructed by Mr. Charles J. Bogue, of New York. 1½ col.—*Elec. Wrld. and Engr.*, March 3rd, 1900.

—— *Apparatus for Finsen Photo-therapy.* Additional information regarding the apparatus employed and its instalment. 1 col.—*Elec. Wrld. and Engr.*, March 10th, 1900.

**Medical Electricity.**—*On the Applications of Electricity in Medical and Surgical Practice.* By H. Lewis Jones, M.D. Historical review and discussion of the present methods of using electricity for medical purposes. 8½ cols.—*Elec. Engr.*, March 16th, 1900.

**Radiography.**—*Becquerel Rays.* The article deals with new experiments regarding the rays emitted by uranium compounds and other substances, such as Thorium, Pitchblende, etc., and describes the results obtained by Mme. Curie, of Paris, Dr. Giesel, of Brunswick, etc. (Ill.)—*Elec. Rev.* (London), March, 1900.

## MARINE ENGINEERING AND SHIPBUILDING.

**Ships.**—*The Fouling of Ships.* By W. H. Atherton, B.Sc. Paper read before the Institution of Naval Architects, in South Shields, March 23rd, 1900. The author discussed the causes of fouling, the effects of fouling, the prevention of fouling by metal sheathing, the prevention by fouling compositions, and added some remarks on the natural history of barnacles. 6,028 wds.—*Trans. Inst. Nav. Arch.*, March 24th, 1900.

## MECHANICAL ENGINEERING.

### 1. Boilers, Furnaces, and Fuel.

**Blower Systems.**—*Condensation of Steam in Blower Systems of Heating.* Abstract of a paper by Prof. R. C. Carpenter before the American Society of Heating and Ventilating Engineers, Jan. 25th, 1900, describing the results of experiments made for the purpose of determining the amount of heat transmitted under different conditions of velocity by a blower working under conditions similar to that required for hot-blast heating. 5½ cols.—*Mech. Engr.*, March 17th, 1900.

**Boilers.**—*Corrosion of Marine Boilers.* Abstract of a paper by Mr. John Dewrance, M.Inst.C.E., read at the ordinary meeting of the Institution of Civil Engineers, dealing with the above subject, which has become of increasing importance since the introduction of water-tube boilers and the use of higher working pressure. 1⅛ col.—*Mech. Engr.*, March 10th, 1900.

**Furnaces.**—*A Furnace Tapping Hood.* By E. H Messiter. The removal of smoke from the furnace-houses of smelting works has in the past been attended with considerable difficulty. In the attempt to catch all the smoke in many cases the effort has been to make the openings to the hood or ventilators as large as possible. The writer, on the contrary, concludes that they should be as small as possible, and that the ventilator should remove all smoke and as little of the surrounding air as possible, for which purpose he designed an apparatus which he describes. ¾ col.—*Engrg. and Min. Journ.*, March 17th, 1900.

### 2. Compressed Air.

**Pneumatics.**—*Pneumatic Despatch.* Reproduction of a paper read by Prof. C. A. Carus Wilson, M.A. Full description of the pneumatic system of despatch, which has been proved conclusively in the United States to be thoroughly practical, and which the author would like to see introduced into England for forwarding letters. (Ill.) 5½ cols.—*Engrg.*, March 2nd, 1900.

—— *Portable Pneumatic Tools.* Abstract of a paper by Mr. Ewart C. Amos, M.I.M.E., read at a meeting of the Institution of Mechanical Engineers, in which the author describes various portable pneumatic tools and appliances which have been used in America for a considerable time. (To be continued.) (Ill.) 3 cols.—*Engrg.*, March 2nd, 1900.

—— *Construction of the Curve $P.V^n = C$.* By Professor D. A. Low. In the above equation $P$ usually denotes the absolute pressure of a given mass of a gas when its volume is $V$ and $n$ and $C$ are constants. 4 cols.—*Mech. Engr.*, March 3rd, 1900.

—— *Hints concerning Air Compressors.* By H. H. Kelley. The author gives certain hints on points to be considered in connection with the design of air compressors which are of considerable importance for securing an effective apparatus. (Ill.) 4½ cols.—*Engr.* (Cleveland), March 1st, 1900.

**Liquid Air.**—*Liquefaction of Atmospheric Air.* Lecture delivered by Captain Franz Walter, Professor of Chemical Technology at the Imperial Military Academy at Vienna, before the Society of Austrian Engineers and Architects, Jan. 13th, 1900. 9½ and 7½ cols. respectively.—*Ztschrft. d. Oest. Ing. u. Arch. Ver.*, March 2nd and 9th, 1900.

—— *Linde Liquid Air Machine at the University of Michigan.* By Alfred L. Davenport. Description of the modern type of Linde's machine, which delivers liquid air at a cost of about one penny a pound. (Ill.) 1 col.—*Engrg. News*, March 8th, 1900.

### 3. Engines and Motors.

**Automobiles.**—*The Thomson Steam Phaeton.* Description of a vehicle built by Mr. Herbert Thomson, engineer at Armadale, Victoria, Australia, which was tried over a five-mile run by Professor Kernot, M.I.C.E., of Melbourne university, and declared by him to be very satisfactory and fully equal to the best motors built elsewhere. (Ill.) 1 col.—*Autom. Journ.*, March, 1900.

—— *Electric Automobiles.* Abstract of a paper by Mr. Elmer A. Sperry, read before the American Institute of Electrical Engineers. Account of the special advantages and the special requirements of the use of electricity in automobiles. (Ill.) 4½ cols. —*Autom. Journ.*, March, 1900.

**Automobiles.**—*Operating Costs of Horse and Electric Delivery Wagons in New York City.* Abstract of a paper read before the American Institute of Electrical Engineers by Messrs. G. F. Sever and R. A. Fliers, presenting the results of an investigation, carried on during the past year in the city of New York, of the operating costs of the horse and electric delivery service, as at present instituted by the large delivery stores. This investigation formed part of a graduation thesis in the Electrical Engineering Department of Columbia University. 3⅜ cols.—*Autom. Journ.*, March, 1900.

—— *Trolley-Fed Automobiles in France.* Description of a trolley-fed automobile system which is now being experimented with on a line somewhat over half a mile in length on a road along the Seine just outside the limits of Paris. The inventor of the system is M. Lombard-Gerin. (Ill.) 2½ cols.—*Elec. Wrld. and Engr.*, March 10th, 1900.

—— *The ordinary Types of Automobiles.* By Prof. H. Bachner, Stuttgart. (Continuation.) The present article deals with the subject of "gearing." (Ill.) 6 cols.—*Dingler's Polyt. Journ.*, March 10th, 1900.

—— *The ordinary Types of Automobiles.* By Prof. H. Bachner Stuttgart. (Continuation.) This instalment discusses "uniformity of motion," and describes the arrangement in Henriot's motor, motor espérance, system Hautier, cyclone motor, Planteau system, Koch motor, etc. 5¼ cols.—*Dingler's Polyt. Journ.*, March 17th, 1900.

**Bicycles.**—*Variable Gearing of Bicycles*, from the hygienic and technical point of view. By Mr. A. Hoelken, Engineer, and Dr. Paul Richter. The article demonstrates the value of variable gearing from a hygienic point of view. (To be continued.) 5¼ cols.—*Dingler's Polyt. Journ.*, Feb. 24th, 1900.

—— *Variable Gearing for Cycles*, from a hygienic and technical point of view. By Mr. A. Hoelken, Engineer, Charlottesburg and Dr. Paul Richter of Berlin. (Conclusion.) (Ill.) 3¾ cols.—*Dingler's Polyt. Journ.*, March 3rd, 1900.

**Cargo-Boat Machinery.**—*Twenty years of Progress in Cargo-Boat Machinery.* Paper by Mr. J. F. Walker. The author points out that the history of Modern Engineering in general for the two decades terminating 1899, is the history of the adoption and triumph of multiple expansions and high pressure. 5 cols.—*Inst. Mar. Engrs.*, Feb. 1900.

**Cranes.**—*100-Ton Shear with Adjustable Boom.* Description of a crane of peculiar construction which has recently been installed at the shipyards of Blohn and Voss, at Hamburg, Germany, and was erected by the Duisburger Maschinenbau Gesellschaft. (Ill.) 1 col.—*Mech. Engr.*, March 10th, 1900.

**Engines.**—*Types of Continental Meter-Gauge Engines.* In many respects continental railway practice differs very considerably from British, particularly in the arranging of the wheels and the position of the cylinders in relation to the boilers. The present article deals with these and other differences. 2½ cols.—*Railw. Engr.*, March 1900.

—— *Triple-Expansion Mill Engine.* Description of a mill engine built by Messrs F. Ringhoffer, Smichow, near Prague, Austria-Hungary, for the Schmieger Spinning Works at Zwodan, Bohemia. (Ill.) 1¼ col.—*Mech. Wrld.*, March 16th, 1900.

—— *Four-Crank Triple-Expansion Engines for High-Speed Launch.* Description of a High Speed Steam Launch built by Messrs. Simpson, Strickland and Co., Ltd., Dartmouth, which has several interesting features in design. (Ill.) ½ col.—*Engrg.*, Feb. 2nd, 1900.

—— *The Steam Engine at the end of the Nineteenth Century.* Abstract of a paper by Dr. Robert H. Thurston, Cornell University, read before the American Society of Mechanical Engineers, New York. 3½ cols.—*Engrg.*, Feb. 23rd, 1900.

**Engines.**—*Automatic High-Speed Engines.* Concise description of a great number of high-speed engine types, constructed by various American manufacturers, and comments on their peculiar advantages and their working. (Ill.) 20 cols.—*Engr.* (Cleveland), Feb. 15th, 1900.

—— *Corrosion of Locomotive Boiler Tubes.* Abstract of a paper published in the 'Baumaterialienkunde," Amsterdam, by Mr. H. Bauke on the corrosion of comparatively new boiler tubes and its causes. (Ill.) 4½ cols.—*Stahl u. Eisen*, March 1st, 1900.

—— *Test of a Special "Porter" Governor.* Description of a series of tests made by Mr. Edwin Reynolds of the Edwin O. Allis Co., in designing the 70,000 h.p. plant for the Metropolitan Street Railway Co. of New York city. (Ill.) 5 cols.—*Mech. Engr.*, March 10th, 1900.

**Engine Works.**—*The Ranelagh Works, Ipswich.* Description of the engine works of Messrs. Reavell & Co., of the Ranelagh Works, Ipswich, in which the buildings have been erected, and the machinery purchased, solely with the view to efficiency and ranking among the model works of this country. (Ill.) 4½ cols.—*Engrg.*, Feb. 9th, 1900.

**Gas Motors.**—*The Increasing Use of Gas Motors in Modern Power Works.* Abstract of an address by Director Münzel, delivered at the meeting of the Cologne District Branch of German Engineers. (To be continued.) 6½ cols.—*Stahl u. Eisen*, March 15th, 1900.

**Pile Driving.**—*Pile-Driving Machines.* By Mr. F. J. Rowan. A paper giving a history and description of pile-driving machinery from the earliest devices up to the most modern types, and discussing their efficiency. 17½ cols.—*Trans. Inst. Engrs. and Shipbldrs.*, Jan., 1900.

**Steam Engine.**—*The Future Development of the Steam Engine.* Paper read by Mr. Alfred Saxon, M.I.Mech.E. The author deals with the progress and evolution of the steam engine, with the view of gauging from the evidence the probabilities of its future development. 6½ cols.—*Trans. Manchester Ass. Engrs.*, Feb., 1900.

## 4. Power and Transmission.

**Wave Power.**—*Can the Waves of the Ocean be Harnessed?* The article deals with a system for utilising wave power by directing them into a large funnel, and thus concentrating their force near the narrow portion. The inventor is Mr. Stephen H. Emmens. 2½ col.—*Electricity* (New York) March 7th, 1900.

## 5. Miscellaneous.

**Fans.**—*Method of Testing Blowing Fans.* By Prof. R. C. Carpenter. The author describes suitable methods for determining the capacity of fans either to move a given volume of air or to produce a certain pressure or both, and also for determining the power required for moving a given quantity of air under a certain pressure; and, finally, the efficiency of the fans. 4 cols.—*Mech. Engr.*, March 24th, 1900.

**Lubrication.**—*Air as a Lubricant.* By Herman S. Heichert. Description of a machine designed by Prof. Albert Kingsbury, of the Mechanical Department of the Worcester Polytechnic Institute. (Ill.) 1½ col.—*Engrg. News*, March 8th, 1900.

**Power Hammer.**—*Improvement in the Longworth Power Hammer.* Abstract of a paper by Mr. Ernest Samuelson, read before the Institution of Mechanical Engineers, describing the advantages of the principle upon which Mr. Longworth has improved his hammer (Ill.) 2½ cols.—*Ir. and Coal Trds. Rev.*, March 2nd, 1900.

**Propeller Wheels.**—*Moulding a Propeller Wheel in Green Sand.* By R. H. Palmer. The author shows one way of moulding a propeller wheel with four blades from a pattern of one blade in green

sand. The wheel is about 6 ft. 9 in. in diameter. (Ill.) 2½ cols.—*Am. Mach.*, March 1st, 1900.

**Sampling.**—*Geissler's Sampling Apparatus.* Description of an extremely simple and accurately working sampling apparatus, designed by Mr. Geissler, chief engineer of the Royal Salt Mines of Germany, and manufactured by Messrs. Fried. Krupp, Grusonwerk, at Magdeburg, Buskan, Germany. (Ill.) 1 col.—*Chem. Trds. Journ.*, March 10th, 1900.

**Typewriters.**—*The Construction of Typewriters.* By A. Beyerlen, Engineer. Discussion of the special advantages and drawbacks, characterising several kinds of typewriters, specially emphasising the merits of the Yost typewriter. (Ill.) 9½ cols.—*Dingler's Polyt. Journ.*, March 10th, 1900.

**Screws.** *Screw Milling Machine.* Description of a machine patented by Mr. H. Liebert, managing director of Messrs. John Holroyd and Co., Ltd., Perseverance Works, Milnrosa, Rochdale, for which the patentee claims that by it screws can be cut at a far greater speed than has hitherto been possible. (Ill.). 1½ col.—*Engrg.*, Feb. 9th, 1900.

—— *The Standardisation of Screw Threads.* (Continued.) The article deals with Sellers system (1884), the French Marine Standard (1865-7), Steinlen's System (1873), the Prussian State Railway System, the Northern of France and Orleans Railways System, the Western and State Railways of France System, the Eastern Railway of France System, the Paris, Lyons and Mediterranean Railway System, the Lombards System, the Delisle Systems, the Saarbrück Engineers' System, and the Reuleaux System. 6½ cols.—*Engrg.*, Feb. 2nd, 1900.

—— *The Standardisation of Screw Threads.* (Continued). Description of the Kreutzberger System (1876), the Italian Artillery System, the Thurz System, the System of the German Engineers' Association (1888), the French Artillery System (1891), the System of the Paris Société d'Encouragement (1894), the Swiss Executive Committee's System (1898), the System of the Turin Society of Engineers and Architects, and the International System (1898), proposed by the recent Congress and recommended by that body. ½ col.—*Engng.*, Feb. 9th, 1900.

**Small Tools.**—*Portable Pneumatic Tools.* By Ewart C. Amos. Abstract of a paper read before the Institution of Mechanical Engineers, describing a great number of types of portable pneumatic tools and their working. 6½ and 3½ cols. respectively.—*Mech. Wrld.*, March 16th and 23rd, 1900.

**Spectroscope.**—*Michelson's Echelon Spectroscope.* Description of a spectroscope which Mr. A. Hilger, of Stanhope Street, London, N.W., exhibited at the Royal Society Conversazione in May last year. (Ill.). 5 cols.—*Engrg.*, Feb. 23rd, 1900.

**Wire Making.**—*Automatic Reels.* The article deals with certain improvements in reeling rods stated in a paper by Mr. M. Baackes, read before the meeting of the Society of German Ironworkers, and dwells on the advantages of an apparatus devised by Messrs. Morgan and Daniels. (Ill.) ¾ col.—*Am. Mftr.*, March 8th, 1900.

## MINING AND METALLURGY.

### 1. Coal and Coke.

**Coal Mining.**—*Coal-Washing Plant at Cadeby Colliery.* Description of a plant recently erected by the Cadeby Colliery, near Doncaster, for the Denaby and Cadeby Main Collieries, Ltd., designed for the treatment of 1,000 tons of coal per day of ten hours. (Ill.) 1½ col.—*Coll. Guard.*, March 23rd, 1900.

—— *Fowler's Hydraulic Decking Arrangement.* Description of the hydraulic decking arrangement at Cinder Hill Colliery, Nottingham, invented by Mr. Fowler to save the time taken up in changing the decks of the winding cages. (Ill.) ¾ col.—*Coll. Guard.*, March 23rd, 1900.

**Coal Mining.**—*Under-Sea Mining at Arnao, Spain.* Description of a mine of the Real Compania Asturianain the Asturias, near the town of Avilés, which partly extends under the Bay of Biscay. (Ill.) 3¾ cols.—*Coll. Guard.*, March 16th, 1900.

—— *Coal Famine in Germany.* By Consul-General Frank H. Mason. The Consul-General of the United States at Berlin deals with the causes of the coal famine in Germany, and the probable effect upon the output of pig-iron, etc. 1¼ col.—*Am. Mftr.*, March 15th, 1900.

—— *Boring a Pair of Shafts through Heavily-Watered Measures.* Extracts from a communication to the "Société des Ingénieurs des Mines du Hainaut." By M. L. Petit, Engineer at the Produit Colliery, near Mons, Belgium. The author describing the boring of two shafts for working the seam in the northern slope of the Couchant de Mons basin, which had to pass through heavily watered measures. (Ill.) 5 cols.—*Coll. Guard.*, March 23rd, 1900.

—— *A New Method for Working Deep Coal Beds.* By H. M. Chance, Philadelphia, Pa., U.S.A. Abstract of a paper read before the American Institute of Mining Engineers, Feb. 1900. (Ill.) 1½ col.—*Coll. Guard.*, March 2nd, 1900.

**Coke Oven.**—*A Coke-oven Plant for the supply of Illuminating Gas.* Article reproduced from the "Progressive Age," describing a coke-oven plant erected at Everett near Boston, U.S.A., for the manufacture of coke and the supply of illuminating gas as a by-product. (Ill.) (To be continued.) 6 cols.—*Ir. and Coal Trds. Rev.*, March 2nd, 1900. (Continued.) 5½ cols. March 9th, 1900.

—— *A New Coke Oven.* Description of a greatly improved coke oven devised by Dr. Von Bauer, Germany, of which a battery has been tried for two years in the Hanover collieries of the F. Krupp, Co., Westphalia, and given excellent results. (Ill.) 4½ cols.—*Ind. and East. Engr.*

**Coke Manufacture.**—*Automatic Treatment of Coke, Brouwer's System.* Description of the most extensive and important installation of this system in France, situated at the Gas Works at Rouen, rue des Emmurées. (Ill.) 2½ cols.—*Le Gaz*, March 15th, 1900.

**Testing Coal.**—**X**-*Rays in Examination of Coal.* Abstract of a communication of Prof. Henri Carnot, of the École Centrale des Arts et Manufactures, Paris, in which he points out the advantages of radioscopic analysis of coal. (Ill.) 2 cols.—*Engrg. and Min. Journ.*, March 17th, 1900.

—— *A Laboratory Method for the Analysis of Coals for Gas Manufacture.* A paper by Mr. J. G. A. Rhodin, F.I.C., read before the meeting of the Manchester Section of the Society of Chemical Industry on Jan. 5th. 3½ cols.—*Journ. of Gas Lghtng.*, Feb. 20th, 1900.

—— *Coal Analysis.* Summary of the report of the Committee on Coal Analysis of the American Chemical Society, which recommends certain methods of analysis, many of which were formulated from experiments performed for this purpose. 3 cols.—*Engrg. Rcd.*, Feb. 10th, 1900.

—— *The Workmen's Compensation Act in relation to Collieries.* Discussion of the measure on the basis of information given by leading insurance offices and from other sources, showing how this Act will operate as regards collieries. 2 cols.—*Coll. Guard.*, Jan. 12th, 1900.

**Collieries.**—*The Vereeniging Collieries.* Description of important South African collieries and their working, accompanied by illustrations. 4 cols.—*Ir. and Coal Trds. Rev.*, Jan. 5th, 1900.

### 2. Copper.

**Copper Formation.**—*Notes on the Formations of Copper "Trees" and "Nodules."* By Sherard Cowper Coles. Description of the various formations of electro-deposited copper, and explanation of the causes. ⅝ col.—*Elect'n.* (London), Dec. 22nd, 1899.

**Copper Production.**—*Copper in 1899.* Statement regarding the production of copper in 1899, and reports of the London and New York copper markets. 10 cols.—*Engrg. and Min. Journ.*, Jan. 6th, 1900.

### 3. Gold, Silver, and Diamonds.

**Gold Mining.**—*A Paying Gold Mine Six Hours from London.* Description of the plant and working of the St. David's Gold and Copper Mines, Ltd., in Wales, which yields 2 oz. of gold per ton, and has been in work for two years, the company being actually able to pay a dividend. 5 cols.—*Min. Wld. and Engr. Rcd.*, March 10th, 1900.

**Mining.**—*The Gold Zone of Copalquin, Durango, Mexico.*—The author describes the San Fernando Mines, and a limited portion of that immense gold-bearing belt that extends from Alaska to Cape Horn. The Fernando Mines are perhaps the most modern establishment of its kind in all Mexico. (Ill.) 2¼ cols.—*Engrg. and Min. Journ.*, Feb. 24th, 1900.

### 4. Iron and Steel.

**Iron Furnace.**—*Talbot's continuous Siemens-Martin Process.* Description of the working of the process in the Pencoyd Iron Works of the A. and P. Roberts Company. 5½ cols.—*Stahl u. Eisen*, March 1st, 1900.

**Iron Works.**—*Comparison of American and British Blast-Furnace Practice.* By Mr. T. B. Rogerson. Abstract of a paper read before the West of Scotland Iron and Steel Institute, in which the author takes as a basis of comparison the blast-furnace practice of Scotland at the present day. (Ill.) 4 cols.—*Ir. and Steel Trds. Rev.*, March 24th, 1900.

**Magnetisation.**—*The Magnetic Measurement of Iron and Steel.* It is of importance for the electric engineer to know the quality of the iron and steel he uses in the construction of his dynamos, especially as far as its magnetisation and permeability are concerned. This can be determined, as Professor Silvanus P. Thompson has shown, by magneto-metric methods, balance methods, inductive methods and traction methods. The author, Mr. J. Warren, discusses the various methods in this order. 2 and 2¼ cols. respectively.—*Electricity* (London), March 2nd, 1900.

### 5. Mining.

**Mining.**—*Mining in Queensland.* The article reproduced from the Gladstone "Observer," contains a graphic description of certain discoveries in the Gladstone District which opens up great possibilities, provided that the statements, which there seems to be no reason to doubt, are based on fact. 4 cols.—*Austr. Min. Stand.*, Jan. 18th, 1900.

**Ore Crushing.**—*A New Form of Roll Crusher for Rock and Ore Crushing.* Description of the design and construction of a new form of roll crusher, which it is thought will be an improvement in several respects over the ordinary machinery. 2 cols.—*Engrg. News*, March 8th, 1900.

**Platinum.**—*Does Platinum occur in Arizona?* The announcement a few months ago of the discovery of great platinum deposits in the region of Cataract Canyon, on the Colorado beyond Williams was hailed with much delight in the United States; but Prof. William P. Beale, of the Arizona School of Mines, who analysed the specimens, denies the truth of the discovery. 1 col.—*Engrg. and Min. Journ.*, Feb. 24th, 1900.

### 6. Miscellaneous.

## MUNICIPAL ENGINEERING.

### 1. Gas Supply.

**Carburetted Gas.** *Carburetted Water Gas.* Description of and comments regarding the process devised by Dr. Strache. The author, M. G. Jouanne, Engineer, discusses the advantages of water gas, and the low price of its manufacture. 2⅝ cols.—*Le Gaz*, March 15th, 1900.

**Gas.**—*Pumping Gas Five Miles at Twenty Pounds Pressure.* Paper read by F. H. Shelton before the New England Association of Gas Engineers. The author advocates the opinion that transferring and distributing artificial gas at high pressure involves neither any great experiment nor any particular risk, and describes a high-pressure system constructed by him in Pennsylvania. 4¼ cols.—*Gas Wrld.*, March 17th, 1900.

**Gasworks.**—*The Charlottenburg Gasworks.* Abstract of article (translated) of Mr. A. Müller, Director of the Charlottenburg Municipal gas undertakings, describing the above works, which were recently visited by the Institution of Gas Engineers. 2 cols.—*Gas Wrld.*, March 24th, 1900.

—— *The Production of Liquor Ammoniac from Gas Liquor.* Abstract of a communication by Dr. Otto Pfeiffer, of Magdeburg, published in the "Journal für Gasbeleuchtung," in which he describes certain improvements devised by him in the process of manufacturing liquor ammoniac direct from gas. 2½ cols.—*Journ. of Gas Lghtg.*, March 13th, 1900.

**Standards of Light.**—*Some Fantastic Standards of Light.* Abstract of a paper by Mr. J. E. Petavel, communicated to the Royal Society, and dealing with researches carried out by him in the Davy-Faraday Laboratory, on several electrical and platinum standards of light. 2 cols.—*Journ. of Gas Lighting*, Feb. 20th, 1900.

### 2. Sewerage.

**Sewerage.**—*Sewer Ventilation.* By A. Prescott Folwell, M.Am.Soc.C.E. The author has for several years studied the practice of American cities in sewer ventilation, and gives in this paper a summary of the data obtained, prefaced by a brief general discussion. 5⅝ cols.—*Engrg. Rcd.*, March 3rd, 1900.

**Sewers.**—*A New Sewer Invert Block.* Description of a block designed by A. N. Talbot, for the purpose of concentrating the minimum flow in a sewer in a channel of small radius. 1¼ cols.—*Engrg. Rcd.*, Jan. 6th, 1900.

### 3. Streets and Pavements.

**Pavements.**—*Brick Pavements from a Contractor's Point of View.* Abstract of a paper by Mr. George R. Grimes on the construction of brick pavements, read at the meeting of the National Brick Manufacturer's Association, New York.—3⅜ cols.—*Engrg. Rcd.*, Feb. 24th, 1900.

### 4. Water Supply.

**Bell-Mouthed Pipes.**—*A Record of Experiments on Flow of Water over Bell-Mouthed Pipes.* By Mr. John Barr. As the formula given for the discharge of water over bell-mouthed pipes has, under certain conditions, been found to be unreliable, experiments were undertaken by the author to get accurate deliveries under given experimental conditions with the object of applying the result to deliveries by telescopic bell-mouthed over-flows of filtered water in filter draw-off wells. 5 cols.—*Trans. Inst. Engrs. and Shipbldrs., Scotland*, Dec., 1899.

**Garbage.**—*The Barren Island Garbage Reduction Works, Greater New York.* Description of the largest garbage disposal works of the world, having a capacity of 1,000 tons a day, and capable even of disposing of 1,500 tons a day; the garbage

being converted into marketable grease and fertilised material. (Ill.) 9 cols.—*Engrg.*, Feb. 1st, 1900.

**Water Pipes.**—*Prevention of Bursting of Water Pipes by Frost.* Description of an invention by Mr. Nevil Monroe Hopkins, consisting of air domes attached to the pipes at intervals of 10 ft. each, in which the ice enters, merely compressing the air but not bursting the pipes. The patent has been acquired by the Pneumatic Dome Manufacturing Company, U.S.A. (Ill.) 1½ col.—*Elec. Wrld. and Engr.*, March 3rd, 1900.

**Water Purification.**—*The Purification of Water after its Use in Manufactories.* Abstract of two papers read on the subject before the meeting of the British Inst. of Engrs., one by Reginald A. Tatton referring to the Mersey and Irwell Watershed, the other by W. O. E. Meade-King referring to experiments made with the object of remedying the evil. 1¾ col., Jan. 19th, 1900.

**Water-Motors.**—*The Construction of small Water-Motors.* By P. Pitman. The author describes in an elementary but adequate manner the principles underlying the action of water-motors, and the application of these principles to their design and construction on a small scale. (Ill.) 3 cols., 2½ cols., and 1½ col. respectively.—*Electricity* (London), March 9th, 16th, and 23rd, 1900.

**Waterworks.**—*The Brightwood Reservoir, Washington, D.C.* Description of a new reservoir connected with the Washington City Waterworks, which is to consist of two symmetrical basins each of 15,000,000 capacity, one of which has recently been completed and put into use. 2½ cols.—*Engrg. Rcd.*, March 3rd, 1900.

—— *The Sanitary State of Falmouth.* Comments on the report of Dr. G. S. Buchanan, who was deputed by the Local Government Board to inquire into the sanitary condition of Falmouth, on account of the prevalence of enteric fever there. 2 cols.—*Surveyor, etc.*, March 16th, 1900.

—— *Loughborough Corporation Waterworks.* The article deals with special features of the progress of the work and the installations at the Blackbrook Reservoir. 2 cols.—*Surveyor, etc.*, March 16th, 1900.

—— *The Water Works of Merthyr Tydfil.* Abstract of the account given of this water supply by Mr. Thomas F. Harvey, engineer and surveyor to the Merthyr Tydfil Urban District Council, in a report presented to the Association of Municipal and County Engineers at a district meeting. (Ill.) 4½ cols.—*Engrg. Rcd*, March 10th, 1900.

## 5. Miscellaneous.

**Drainage.**—*The Drainage of New Orleans.* By L. W. Brown, M.Am.Soc.C.E., Chief Engineer, National Contracting Co., New Orleans, La., U.S.A. Description of drainage plant of the most modern kind, which promises to render New Orleans the best sewered, watered and drained city in the United States. (To be continued.) (Ill.) 8½ cols.—*Engrg. News*, March 15th, 1900.

—— *Bombay Surface Water Disposal and Subsoil Drainage.* Summary of the report of Mr. Santo Crimp on the above subject submitted to the Municipal Corporation of Bombay, which had entrusted him with drawing up such a document. (To be continued.) (Ill.) 9 cols.—*Ind. and East. Engr.*, Feb., 1900.

—— *Municipal Engineering.* Description of one of the most striking features connected with the drainage work at New Orleans, namely, the seven large screw pumps designed by the Edward P. Allis Company of Milwaukee, each of which raises 250 cubic feet of water per second three feet. (Ill.) ⅞ col.—*Mod. Machinery*, Feb., 1900.

**Garbage Destruction.**—*The Utilisation of Garbage for Fuel.* Letters on the subject by George Westinghouse, R. H. Thurston, and Cary P. Hutchinson. 3 cols.—*Engrg. Rcd.*, Jan. 20th, 1900.

# NAVAL & MILITARY ENGINEERING.

**Guns.**—*Modern Field Artillery.* The article deals with the 37 millimeter automatic gun, constructed by the Vickers, Sons & Maxim Co., which has attracted so much attention by its use in the Transvaal war. (To be continued.) (Ill.) 4½ cols.—*Engng.*, March 2nd, 1900.

—— *Vickers' Automatic 14-Pounder Gun.* Description of a 14-pounder gun, the breech mechanism of which is practically automatic, built recently for the United States Government, which, if the trials should be successful, will be adopted generally in the U.S. Navy. (Ill.) 1½ cols.—*Engrg.*, Feb. 9th, 1900.

—— *Messrs. Schneider & Co.'s Works at Creusot. No. LXXVIII.* The article deals with mortars for coast defence, and describes a 27-centimetre (10,630 in.) coast defence mortar, a 30-centimetre (11,811 in.) muzzle-loading rifled mortar, 1883 pattern, a 12-centimetre (4,724 in.) 26-calibre quick-firing coast defence gun, a 12-centimetre (4,727 in.) 40-calibre quick-firing coast defence gun, and a 6 in. 50-calibre quick-firing coast defence gun. (Ill.) 2½ cols.—*Engng.*, Feb. 2nd, 1900.

—— *Messrs. Schneider & Co.'s Works at Creusot. No. LXXX.* The present article deals with guns on disappearing carriages, and describes a 15-centimetre (5,905 in.) 26-calibre gun, a 24-centimetre (9,448 in.) gun on disappearing carriage with counterweight, and a 27-centimetre (10,630 in.) 28-calibre gun. (Ill.). 6 cols.—*Engng.*, Feb. 23rd, 1900.

**Navy Yards.**—*New York Navy Yard.* Description of the construction and equipment of the most important of the navy yards of the United States, namely, that officially known as the Navy Yard, New York, and popularly as the Brooklyn Navy Yard. (Ill.) 2½ cols.—*Sci. Am.*, March 3rd, 1900.

**War Vessels.**—*Our Latest Protected Cruiser the "Albany."* Description of a new American cruiser which, in all essentials, is an exact duplicate of the "New Orleans." Like the latter it is one of the vessels originally built for Brazil, and bought during the Spanish-American war by the United States. (Ill.) 2 cols.—*Sci. Am.*, March 10th, 1900.

—— *The Classification of War-ships.* By Fred. T. June. The author finds fault with the Admiralty's rating of war-vessels which, he says, appears, more often than not, to depend upon what is wanted to be proved, and proposes a new classification of his own. 5½ cols.—*Engr.*, March 9th, 1900.

# RAILWAY WORK.

## 1. Motive Power and Equipment.

**Railways.**—*Early Models of Railways and Locomotives.* In early railway days experimental devices on a small scale, from the merest toys to railways capable of carrying a few people, were often exhibited. The present article describes each exhibit. 2¾ cols.—*Engr.*, Feb. 23rd, 1900.

—— *The Oelwein Shops—Chicago Great Western Railway.* Description of the new shops of the above railway, located at Oelwein, Iowa, U.S.A., which in some regards are the most noteworthy in the United States, not as regards size, or the amount of work performed there, but on account of the novel arrangement with reference to the transfer table, the judicious provision for future enlargement, the architectural details and devices for lighting, heating, and ventilation, and finally, the almost exclusive employment of electricity and compressed air for power. (Ill.) 11 cols.—*Railw. Master Mech.*, March, 1900.

## 2. New Projects.

### 3. Permanent Way and Fixtures.

**Tunnels.**—*The New York Rapid Transit Tunnel.* Description of a stupendous engineering undertaking far excelling any work of the kind elsewhere, though the details of construction and the manner of executing the work are not so very difficult to understand. The account gives a clear outline of the main features. (Ill.) 3 cols.—*Elec. Rev.* (London), Feb. 16th, 1900.

—— *The Turchino Tunnel.* Description of a tunnel, having the length of four miles, running under the Apennines, and situated on the Genoa and Asti Railway in Italy. ⅝ col.—*Engr.*, Feb. 23rd, 1900.

**Switching and Signalling.**—*Electro-Pneumatic Switching and Signalling System at the South Boston Terminal Station.* Description of a very interesting system of switching and signalling, constructed with special regard to the vast size and peculiarities of the above station at South Boston, Mass., U.S.A. (Ill.) 1¾ col.—*Sci. Am.*, March 3rd, 1900.

### 4. Transportation and Conducting.

**Running Trains.**—*The Cost of Running High Speed Trains.* Abstract of a paper by F. A. Delano, Superintendent of Motive Power, Chicago, Burlington, and Quincy R. The author comes to the conclusion that speed costs heavily, but what the increase of cost really is has still to be investigated. 8½ cols.—*Railw. Engr.*, March, 1900.

### 5. Miscellaneous.

**Electric Railway.**—*The Akron, Bedford, and Cleveland Electric Railway.* Description of a railway in the State of Ohio, U.S.A., on which electricity is the motive power, and which forms an excellent example of the important benefits which may be derived from an electric railroad in spite of the fact that the route traversed parallels steam railroads. 5 cols.—*Elec. Rev.* (New York), Feb. 28th, 1900.

**Electricity for Railways.**—*Notes on Electric Traction under Steam Railway Conditions.* Abstract of a paper by Edward C. Boynton, read before the 140th meeting of the American Institute of Electrical Engineers, New York, Feb. 28th, 1900. 8½ cols.—*Electricity*, March 7th, 1900.

—— *Notes on Electric Traction under Steam Railway Conditions.* Abstract of a paper by Edward C. Boynton, M.Am.Inst.Elec.E. 6 cols.—*Engrg. News*, March 8th, 1900.

—— *Notes on Electric Traction under Steam Railway Conditions.* By Edward C. Boynton. The author discusses the advantages to be derived from the use of electricity instead of steam on certain overcrowded railway lines. (To be continued.) 3 cols.—*Elec. Rev.* (New York), March 14th, 1900.

—— *Electricity in the Service of Urban Railways.* Summary of a lecture by C. Lorenz, held on Feb. 6th, in the Club of Austrian Railway Officials. The author points out that the limit of steam power in the service of urban railways has been reached, and that electricity forms a welcome substitute. (To be continued.) 4 cols.—*Electro-Techniker*, Feb. 28th, 1900.

**Accidents to Railway Servants.**—*Report of the Royal Commission on Accidents to Railway Servants.* Abstract of the Report of the Commission appointed last year into the causes of accidents, fatal and non-fatal, to servants of railway companies and truck owners. 7¼ cols.—*Railw. Engr.*, March, 1900.

## STREET AND ELECTRIC RAILWAYS.

**Electric Tramways.**—*The Norwich Electric Tramways.* Description of a system of tramways, now rapidly nearing completion, which will, when finished and at work, prove as excellent an example of the capabilities and desirability of the overhead system as could be wished. (Ill.). 7 cols.—*Light Ry. and Tramw. Journ.*, March, 1900.

**Electric Tramways.**—*Modern Tramway Construction.* III. The article deals with the various types of boilers adopted in the United Kingdom, and their special advantages or drawbacks for providing the power needed for the dynamos. (Ill.) 10 cols.—*Light Ry. and Tramw. Journ.*, March, 1900.

—— *The Surface Contact System of Diatto.* Abstract of a lecture by M. Pedriali, published in the "Bulletin de la Société Belge d'Electriciens." (Ill.) 1½ col.—*Electro-Techniker*, March 15th, 1900.

**Electric Railways.**—*Single Rail Suspended Electric Railway, Vohwinkel Elberfeld Barmen.* Description of this special type of electric railway, of which an installation in the Wupper Valley, Germany, will be opened to traffic within the next few weeks. The whole line will have a length of 1,33 km. (Ill.) 9⅛ cols.—*Stahl u. Eisen*, March 15th, 1900.

**Overhead Lines.** *The Construction of Overhead Equipments.* The article gives a brief account of the work of construction of an overhead line for tramway work, with a view to pointing out some of the difficulties that have to be encountered. (To be continued.) 3 cols.—*Elec. Rev.* (London), Feb. 23rd, 1900.

## TRADE AND ECONOMICS.

### 1. Commerce and Trade.

**China.**—*Views on China Trade.* Article dealing with the general commercial conditions of China, with special reference to the United States, whose trade in the Shantung province and on the north coast of the Pechili Gulf, has greatly developed of late. 5½ cols.—*Mftr.*, Feb. 1st, 1900.

**Cotton Shipping.**—*The Round-Lap Bale Method of Shipping Cotton.* By D. Allen Willey. The "round bale process" is an industry inaugurated during the cotton season of 1896-7, when about 4,000 bales of this kind were shipped from the South, while last year (1899) the shipping of these bales is estimated at 175,000 bales. The standard circular press, compresses each bale with a pressure of 7,500 lbs. to the bale, and when the roll has reached the required dimensions, the covering, which is suspended in a wooden framework, is released and descending is wound mechanically around the bale. The density of the old square bale ranges from 20 to 25 lbs. the cubic foot, that of the modern round bale from 35 to 45 lbs. 3 cols.—*Sci. Am.*, Feb. 24th, 1900.

**India-Rubber.**—*India-Rubber in South America.* Abstract of the report of M. Eugène Poisson, who was sent by the French Government to South America to examine into the India-rubber question. The principal object was to obtain information as well as seed and plants with a view of propagation in the French colonies. 1½ col.—*Sci. Am.*, Feb. 24th, 1900.

### 2. Currency and Finance.

### 3. Government Control.

### 4. Labour.

**Labour.**—*Hand and Machine Labour.* (Continued.) The present article deals with comparisons between hand and machine labour in the Perforating Bank Cheques and Ruling Paper, Boot and Shoe Manufacture, Bread Making, Manufacture of Brick and Drain Pipes, and Button Manufacture. 3½ cols.—*Engrg.*, Feb. 2nd, 1900.

—— *Hand and Machine Labour.* (Continued.) Comparison between hand and machine labour in the manufacture of Carpets, Carriage Parts, and Carriages and Wagons. 3 cols.—*Engrg.*, Feb. 9th, 1900.

## RECENT BOOKS.

1. ***The Elements of Physics, for use in High Schools.*** By Henry Crew, Ph.D., Professor of Physics in North-Western University, New York. The Macmillan Company, 1899.

2. ***Magnetism and Electricity for Beginners.*** By H. E. Hadley, B.Sc. (Lond.), A.R.C.Sc. (Lond.), Head Master of the School of Science, Kidderminster. London, Macmillan & Co., Ltd. 1899.

3. ***Practical Plane and Solid Geometry, for advanced Students;*** *including Graphic Statics, adapted to the Requirements of the Advanced Stage of the South Kensington Syllabus.* By Joseph Harrison, M.I.M.E., Ass.M.Inst.C.E., Instructor in Mechanics and Mathematics at the Royal College of Science, London, and G. A. Baxandall, Assistant in Mechanics and Mathematics at the Royal College of Science, London. London, Macmillan & Co., Ltd., 1899.

4. ***Newton's Laws of Motion.*** By P. G. Tait, M.A., Sec. R.S.E., Hon. Fellow of Peterhouse, Cambridge; Prof. of Nat. Phil. in the Univ. of Edin. London, Adam & Charles Black. 1899.

5. ***Heat, for advanced Students.*** By Edwin Edser, Associate of the Royal College of Science, London; Fellow of the Physical Society of London, Late Senior Demonstrator and Lecturer on Physics at the South-Western Polytechnic Chelsea. London, Macmillan & Co., Ltd. 1899.

Dr. Henry Crew, in his "Elements of Physics," has constantly kept in view the unity of the various forms of energy, and maintained a logical sequence in his treatment of the subjects with which he deals, so that the student progresses smoothly, and without coming across gaps, from one branch of physical knowledge to the other, while the constant application of what he has learned to practical problems renders his acquisition useful, and supplies him with aids to memory which, in a purely descriptive treatment, are lacking. The definitions given are, on the whole, clear and satisfactory, at least as clear as our present status of physical knowledge enables us to formulate them; and finally, Dr. Crew has wisely emphasised the necessity of laboratory experiments, as a purely theoretical study of the sciences is worse than useless.

The little volume of Mr. H. E. Hadley on "Magnetism and Electricity for Beginners" has the direct object of supplying a short text-book for students preparing for the Elementary Stage of the Science and Art Department's Examination in Magnetism and Electricity, and for similar examinations, for which purpose, if accompanied by verbal instruction, no doubt it will suffice. On the whole, however, the author has made the aim of supplying the student with just such facts as will enable him to reply to the questions which he is likely to be asked, somewhat too conspicuous, and the learner who requires a stimulus to self-instruction will find the volume hardly suitable. It is one out of many books of almost equal value, and does not possess, nor pretend to possess, any special features to distinguish it from similar school-books.

The treatise on "Heat," by Mr. Edwin Edser, is a very valuable addition to our educational literature, and thoroughly up to date. The treatment of the subject is lucid and thorough, as far as thoroughness can be expected in a book of limited size dealing with so comprehensive a subject, and its perusal will be an excellent preparation to the understanding of the more advanced works on this branch of physical knowledge. The selection of experiments suggested for the purpose of illustrating the theoretical laws is judicious, and the instruction intended to secure accuracy will, in most cases, be found sufficient, especially as regards the very important thermometrical measurements. The mathematical knowledge presupposed in the student includes the method of expansion by the binomial theorem, and some acquaintance with the infinitesimal calculus, although the author has stated the method of working out the problems very fully, and in this way rendered the section on Thermodynamics accessible to even those who have not much practice in the mathematical treatment of physical laws. The illustrations accompanying the text are clear and abundant, and the little work is in every way acceptable both for self-instruction and reference, while it is at the same time a reliable guide in laboratory practice.

The small introductory volume on "Newton's Laws of Motion," by Prof. P. G. Tait, notwithstanding its limited size of 52 octavo pages, contains a greater amount of practical and useful teaching than many a far more bulky work on physical laws, and, coming from so great an authority, cannot but be excellent in treatment. The emphatic statement regarding the self-dependence of the objective world and its existence regardless of the senses, is characteristic of the author. Its truth will appear to be self-evident to most of our modern students of theoretical and applied sciences; it will most likely, however, evoke a smile on the part of the metaphysician, for whom Prof. Tait, as we all know, has but slight regard. On the whole, the remark might have well been omitted without in the least diminishing the true value of this remarkable little treatise, which could not have been written in so concise and, at the same time, so lucid a form by anyone less thoroughly conversant with scientific research than Prof. Tait.

Messrs. Joseph Harrison and G. A. Baxandall, in their volume on "Practical Geometry," have furnished science students with a very useful aid in the execution of graphical computations, and the careful instructions regarding drawing instruments and their use, if strictly adhered to, will develop a degree of accuracy that cannot but be extremely advantageous in practice. The chapter dealing with the work of plotting on squared paper is a very praiseworthy feature, and the chapter following it is, as was the intention of the authors, well adapted to convey to the students correct notions of projection and the geometry of space.